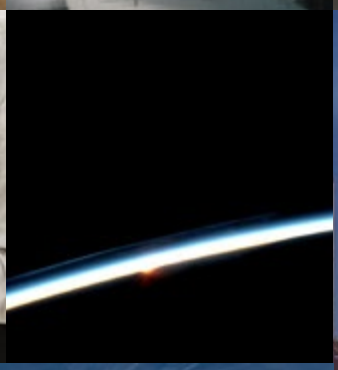
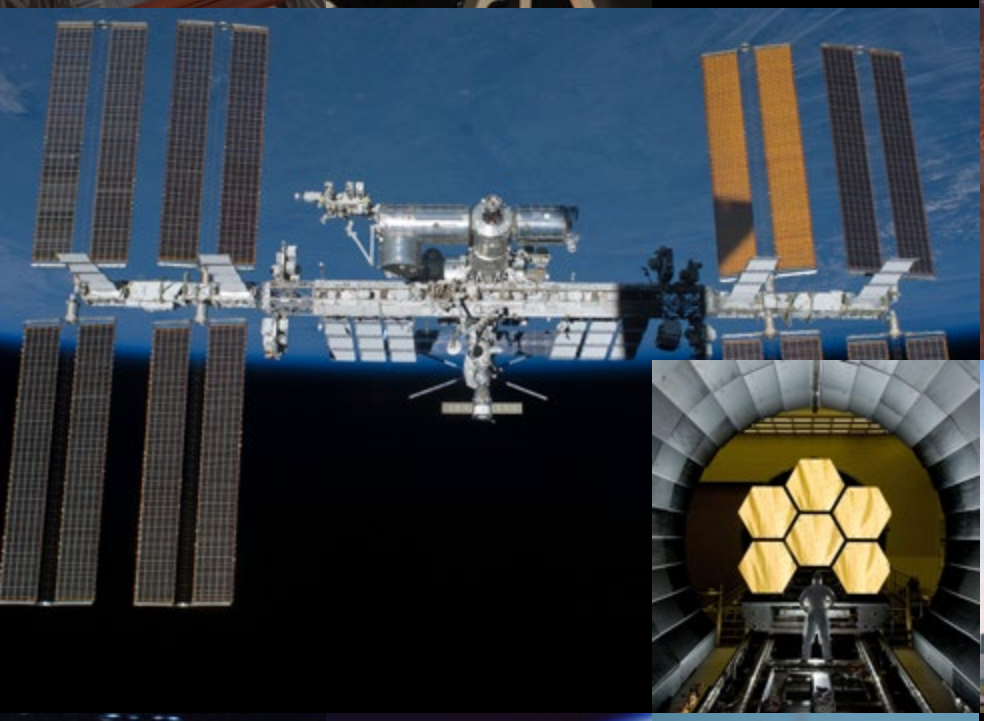
National Aeronautics and Space Administration



PROGRAM CATALOG



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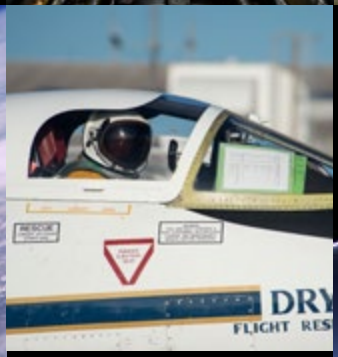
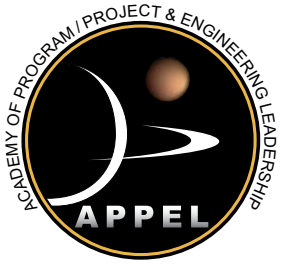


NASA Academy of Program/Project and Engineering Leadership

MISSION STATEMENT

The Academy of Program/Project and Engineering Leadership supports NASA's mission by promoting individual, team, and organizational excellence in program/project management and engineering through the application of learning strategies, methods, models, and tools.

2014 Program Catalog



Office of the Chief Engineer

The NASA Academy of Program/Project and Engineering Leadership

appel.nasa.gov

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Greetings from the Academy Director

As NASA continues to develop new technologies, execute flagship programs such as the Space Launch System and the James Webb Space Telescope, and plan for the future exploration of asteroids, its success hinges on its practitioners having access to the training and learning experiences they need.

The Academy of Program/Project and Engineering Leadership (APPEL) supports NASA's mission by promoting individual, team, and organizational excellence in program/project management and engineering. The Academy continues to offer internationally recognized training, based on an integrated competency model for project managers and systems engineers that aligns with agency standards, policies, and procedures as well as external requirements.

In May 2013, I was appointed director of the Academy, succeeding Dr. Ed Hoffman, who is now dedicating his full time to the role of NASA Chief Knowledge Officer. Stephen Angelillo has assumed the role of deputy director and will continue to oversee the Academy Center for Excellence located at Kennedy Space Center. We continue to work closely together to maintain the high level of integration of the Academy's training and curriculum with the agency's knowledge initiative. I have learned a lot working with Ed over our many years together, and I look forward to continuing APPEL's tradition of innovative thinking, especially as NASA moves forward in a time of constrained resources.

I am pleased to share with you our lineup of courses for fiscal year 2014. Your suggestions and course evaluations have played a critical role in shaping the learning opportunities available through the Academy. We have worked closely with the Systems Engineering Working Group to review and revise our systems engineering curriculum to reflect the latest changes in NPR 7123.1B. Additionally, we collaborated with NASA's training and capability team to reformat the Project Planning, Analysis, and Control course to incorporate more relevant NASA examples. We are also planning to introduce two pilot courses, Basis of Estimate and Systems Modeling, to the project management and systems engineering community.

As we continue to enhance our in-person offerings, a revolution is rapidly unfolding in the world of online training and education. This year, the Academy looks forward to releasing video learning modules from three of its most popular courses—Earth, Moon, and Mars; Introduction to Astronomy for Engineers; and Seven Axioms of Good Engineering. Future efforts will enhance the Academy's curriculum with additional online training opportunities and e-books, leveraging existing resources and course materials that can be shared more widely through technology.

This year's lineup of courses complements the Academy's robust hands-on training programs: the Systems Engineering Leadership Development Program (SELDP), Project HOPE (Hands-On Project Experience), and Rocket University. We are also in the process of developing a "fifth-year curriculum" intended to offer NASA practitioners specialized training that goes beyond the analytical coursework emphasized in undergraduate engineering programs.

Lastly, the Academy is enhancing its online presence and capability with updates to its web site to better display course schedules, organize learning materials, and share current events relevant to the program/project management and engineering community.

It is through your feedback collected from the Academy's courses, web site, and social-media outlets that we are able to improve upon the services we provide to you in order to continue enabling mission success at NASA. I welcome your thoughts.

Roger Forsgren

Director of the Academy of Program/Project & Engineering Leadership

appel.nasa.gov

WHO WE ARE AND WHAT WE DO

Who We Are and What We Do

Who We Are

The Academy of Program/Project and Engineering Leadership (APPEL) is NASA's agency-wide resource for the professional development of the program/project manager, engineer and system engineer communities. We are actively engaged in promoting career and professional development and providing a wealth of information and resources to the technical workforce. The Academy builds NASA's capacity for teamwork, leadership, process utilization, and knowledge through customized programs to meet the specific needs of individuals, teams, and the NASA community. Our products and services are designed to address the competencies required for program/project management, systems engineering and engineering across four levels of career development, from team member to program manager or chief engineer. The Academy addresses the learning needs of NASA's practitioners through its training curriculum, knowledge-sharing events and publications, team development services, and formal development programs.

What We Do

Curriculum

The curriculum enables NASA's technical workforce to develop NASA-specific expertise and capability in project management and engineering. It is intended to supplement an individual's academic and professional work experience. The curriculum draws extensively on best practices and the knowledge of NASA subject-matter experts to ensure it addresses the needs of NASA's practitioners.

Courses are developed following established instructional design processes and include rigorous annual audits and revisions as well as incorporation of participant feedback. The Academy's project management and systems engineering competency models provide the basis for all course objectives. Courses are highly interactive, featuring case study analyses, group discussions, individual exercises, and simulations. Participants are encouraged to learn from instructors and one another.

The curriculum consists of a core curriculum and a wide array of in-depth courses. In combination with work assignments and other developmental experiences, these courses provide essential knowledge and skills that address the learning needs of NASA's technical workforce at all career levels.

The Academy's curriculum has achieved a reputation for excellence within academia and leading professional associations throughout the world. The Project Management Institute, the American Council on Education, and the International Association for Continuing Education and Training all recommend recognition for participation in the Academy's courses.

Core Curriculum

The core curriculum offers a comprehensive, integrated approach to learning for NASA's technical workforce. It consists of four courses: Foundations of Aerospace at NASA, Project Management and Systems Engineering, Advanced Project Management and Advanced Systems Engineering, and International Project Management. The sequence of the materials is designed to help participants expand their thinking—to make connections among many systems engineering and project management principles and concepts, see the "big picture," and

understand the context and interrelationships of the topics. This framework promotes the timely transfer of knowledge and skills into the work environment. Dates and locations can be found on the agency master schedule.

In-Depth Courses

The Academy sponsors in-depth courses in the areas of program/project management, systems engineering, engineering, earned value management, communication and leadership, and NASA's mission and vision, as well as other experiential learning activities. These courses supplement the core curriculum by providing in-depth knowledge and skill development. Participants are not limited to attending courses at their home centers. Dates and locations can also be found on the agency master schedule.

What's New in Curriculum?

The Academy continually seeks to provide new opportunities for learning and professional growth. It conducts regular reviews with participants, educators, and key stakeholders to ensure the curriculum meets the changing needs of the workforce. An example of this is an effort in conjunction with the NASA Program Analysis and Evaluation group to enhance the Project Planning and Control (PPAC) course so that it better reflects the language used by the agency.

Just-in-time learning videos and virtual classroom options have also been developed for some of the curriculum. NASA APPEL plans to present APPEL-ASTRO, APPEL-SAGE and APPEL-EMM entirely by video platform so learners can take the courses at their own pace. See course descriptions for further details as they become available.

APPEL's Academy Center for Excellence (ACE)

The ACE facility serves as a multidisciplinary learning center for the NASA community, which includes civil servants as well as partners in industry, academia, other government agencies, professional associations, and foreign space agencies. ACE's location in the Operations Support Building II (OSBII) at the Kennedy Space Center and its customer-focused approach help foster cross-sector collaborations and new networks that enhance NASA's knowledge base and contribute to the success of its programs and projects. ACE hosts many local APPEL core and in-depth courses, and supports other NASA and partner training organizational offerings throughout the year.

Knowledge Sharing

The Knowledge Sharing initiative promotes excellence in project management and engineering by gathering and sharing knowledge, best practices, and lessons learned from program/project and engineering leaders. This has proven to be an effective strategy for helping to build an agency-wide community of reflective practitioners who understand the necessity of continuous learning and sharing.

What's New in Knowledge Sharing?

Since the appointment of Academy Director Ed Hoffman as NASA's Chief Knowledge Officer (CKO) in early 2012, great strides have been made in coordinating the Academy's knowledge-sharing offerings, which are available across the agency, and those of NASA's centers, mission directorates, and functional organizations (such as the NASA Safety Center).. Twenty-one CKOs and points-of-contact have been appointed

across the agency, and they convene annually to discuss strategies for effective knowledge management within their respective organizations. Monthly conference calls are held to share best practices and to enhance the ways each organization captures, shares and stores knowledge. The NASA CKO briefs the agency's Program Management Council on a quarterly basis on significant developments related to knowledge management.

A new NASA Knowledge Map that identifies the knowledge activities at each center, mission directorate, and participating functional office is now available as an online resource. It employs six knowledge categories that reflect the richness and diversity of knowledge work taking place across the agency today:

- Online Tools
- Search/Tag/Taxonomy Tools
- Case Studies/Publications
- Lessons Learned/Knowledge Processes
- Knowledge Networks
- Fact-to-Face

The knowledge community has also successfully developed a new knowledge policy, which will lead the way to a more strategic and integrated knowledge approach across NASA. The policy establishes a federated model for coordination and collaboration of knowledge activities, empowering local organizations at NASA to devise the right approach for their respective needs.

The NASA knowledge map and all CKO communications can now be found online at km.nasa.gov. This website also hosts the archives for ASK Magazine and ASK the Academy, a calendar of events, links and resources and other content useful to knowledge experts and NASA practitioners alike.

International Project Management

International collaboration in space has evolved significantly over the past fifty years. Today most of NASA's space projects involve international partners and in the years ahead this trend is expected to continue. As it does, there will be increasing interdependencies among space agencies as the cost becomes prohibitive for agencies to pursue projects alone.

The Academy, in collaboration with its international partners, is pursuing several initiatives to incorporate this understanding into the approach it uses to develop NASA's technical workforce. Since 2010, the International Program/Project Management Committee (IPMC)* has brought together space agencies, companies, and educational and professional organizations under the auspices of the International Astronautical Federation. IPMC members exchange information and support each other's program activities in areas such as technical workforce training, lessons learned, best practices in international project management, and knowledge sharing.

Team Development

The Academy supports the engagement of Team Development activities associated with increasing the effectiveness, value and productivity of a team environment and has this resource available to organizations and centers through center-funded initiatives. The Team Development process can include many stages, some of which are outlined on the next page:

Discussions/Sessions

* The IPMC is a group of more than 20 space agencies, companies, and research organizations from around the world that share experiences and best practices involving space project management.

Through one-on-one assistance, focused workshops, or large-group sessions, enhancement interventions achieve immediate project goals while building long-term team capabilities. Assessments and consultations take place between APPEL team development specialists and the NASA project leaders to evaluate these needs and propose developmental activities that specifically respond to the Statement of Work (SOW).

Assessment and Development

Team managers improve project and executive team dynamics most effectively when they assess team and individual behavior. Team Development tools can measure behavioral effectiveness for teams and leaders, as well as measure overall team knowledge. Following assessment, interventions can include workshops, coaching, mentoring, and individual or team consultations with experienced practitioners, many of whom are retired NASA and aerospace industry project managers.

Project Life-Cycle Support and Technical Assistance

APPEL team development specialists can provide expert practitioners support to any competency in any phase of the project life cycle, including team building, planning and scheduling, program control analysis, systems integration support, risk management, and software management—in short, from formulation through implementation and evaluation. NASA teams of all sizes benefit from these customized consultations with expert practitioners.

Formal Development Programs

Since NASA practitioners report that 90 percent of learning takes place on the job, the Academy facilitates on-the-job learning experiences, including developmental assignments and learning from mentors, supervisors, and other senior personnel. Top performers are intrinsically motivated to seek out professional development opportunities—whether in the form of courses, work assignments, or mentoring relationships—simply because they see continuous learning as part of the job. The Academy encourages participants to work with their managers to identify appropriate on-the-job learning experiences that reinforce and supplement classroom learning.

Hands-On Project Experience (HOPE)

The Hands-On Project Experience (HOPE) is a cooperative workforce development program sponsored by the Academy, the Science Mission Directorate, and the Office of the Chief Technologist. Project HOPE provides an opportunity for a team of early-entry NASA employees to propose, design, develop, build, and launch a suborbital flight project over the course of 18 months. The purpose of the program is to enable practitioners in the early years of their careers to gain the knowledge and skills necessary to manage NASA's future flight projects. The Science Directorate at Langley Research Center manages the program.

Systems Engineering Leadership Development Program (SELDP)

The Systems Engineering Leadership Development Program (SELDP), an agency-wide leadership development program, has been designed for high-potential systems engineers who are expected to lead higher-level or more complex systems engineering efforts in the near future. This comprehensive year-long program provides development in the "art" of systems engineering through leadership assessment, training, coaching,

and mentoring, as well as in the "science" of systems engineering through challenging assignments outside the home center.

Developmental assignments are intended to expand the participant's systems engineering experience beyond his or her home center and area of technical expertise and to expose him or her to how systems engineering is practiced at other NASA centers. Participant selection involves identifying individuals who have proven technical/discipline capability and who have demonstrated key leadership capabilities and behaviors. The competitive process ensures that the most qualified individuals are selected for this opportunity at the times in their careers when the learning will have the greatest impact. Individuals must be nominated by their center director and center engineering director for this program.

How to Register for APPEL Courses

NASA Civil Servant and contractor personnel must register for APPEL in-depth courses through the NASA Learning Management System (SATERN) self-registration and 4-step approval process. Learners may access SATERN at https://satern.nasa.gov.

Attendance of APPEL core courses [Foundations of Aerospace at NASA (FOU), Project Management and Systems Engineering (PM&SE), Advanced Project Management and Advanced Systems Engineering (APM&ASE) and International Project Management (IPM) is by nomination only. Please contact your Center Training Office for information regarding your Center's nomination process.

WHAT COURSES TO TAKE AND WHEN

A Guide to Professional Development Planning

What Courses to Take and When

LEVELS OF PROJECT LEADERSHIP The levels of project leadership are guideposts as to when during an individual's career a course can be taken. Individuals should attend courses as they see fit to enhance competencies within their current positions, or for future development requirements.			
Examples of Positions (Read down for suggested courses)			
Team Practitioners/Technical Engineers	Subsystem Leads	Project Managers/Project Systems Engineers	Program Managers/Chief Engineers
CORE COURSES The core curriculum provides fundamental knowledge for NASA's technical workforce.			
• Foundations of Aerospace at NASA	• Project Management and Systems Engineering	• Advanced Project Management and Advanced Systems Engineering • International Project Management*	

*Course can be taken by anyone in a role that deals with international project management issues.

LEVELS OF PROJECT LEADERSHIP The levels of project leadership are guideposts as to when during an individual's career a course can be taken. Individuals should attend courses as they see fit to enhance competencies within their current positions, or for future development requirements.			
Examples of Positions (Read down for suggested courses)			
Team Practitioners/Technical Engineers	Subsystem Leads	Project Managers/Project Systems Engineers	Program Managers/Chief Engineers
IN-DEPTH COURSES These courses are intended to provide in-depth, detailed, and supplemental knowledge and skills for achieving current and future job requirements and augment the core curriculum.			
PROGRAM/PROJECT MANAGEMENT Program and project management (P/PM) training courses are designed to promote the conceptual and practical use of modern P/PM theories and applications throughout all phases of the NASA project life cycle.			
• Project Scheduling • Project Planning Analysis and Control • Risk Management I	• Assessing Project Performance • Orbital Debris Mitigation and Reentry Risk Management** • Performance-Based Statement of Work • Project Acquisition Workshop • Project Review Processes and Strategies • Risk Management II • Scheduling and Cost Control	• Analysis of Alternatives • International Project Management* • Passing the Project Management Professional (PMP)® Examination • Strategic Thinking for Project Success	• Analysis of Alternatives (EXEC)
EARNED VALUE MANAGEMENT The Academy provides extensive training in earned value management (EVM) to ensure that NASA project practitioners understand the uses of this tool for measuring and assessing project performance.			
• Understanding EVM • Integrated Baseline Review • Earned Value Management Systems • Scheduling Virtual Learning Lab • Control Account Manager	• Advanced EVM		
COMMUNICATION AND LEADERSHIP These courses are designed to help internalize the skills that help facilitate open and continuous communications with colleagues, develop personal leadership qualities, and improve negotiation skills.			
• Communicating Technical Issues • Negotiations • Team Membership • Technical Writing for the NASA Engineer	• Crucial Conversations • Team Leadership • Project Management Leadership Lab	• Leading Complex Projects	• Executive Presence and Skills • Consider taking agency leadership courses offered by OHCM.

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**Also listed under Engineering (same course).

LEVELS OF PROJECT LEADERSHIP The levels of project leadership are guideposts as to when during an individual's career a course can be taken. Individuals should attend courses as they see fit to enhance competencies within their current positions, or for future development requirements.			
Examples of Positions (Read down for suggested courses)			
Team Practitioners/Technical Engineers	Subsystem Leads	Project Managers/Project Systems Engineers	Program Managers/Chief Engineers
SYSTEMS ENGINEERING The Academy's systems engineering curriculum provides training in systems engineering processes and tools, and promotes experience-driven technical leadership development.			
• Fundamentals of Systems Engineering • Life Cycle, Processes, and Systems Engineering • Requirements Development and Management • Requirements Development and Management—Team	• Concept Exploration and Systems Architecture • Decision Analysis • Developing and Implementing SEMP • Exploration and Space Operations • Mars Mission and System Design Lab • Space Launch Transportation Systems • Space Systems V and V • Science Mission Systems Design and Ops Course/Lab • Transition, Product Delivery, and Mission Ops		
ENGINEERING The Academy's engineering courses focus on engineering essentials, critical thinking, lessons learned, and space systems to strengthen NASA-specific engineering expertise and capabilities.			
• Essentials of Astronomy for Engineers • Introduction to Aeronautics • Introduction to Green Engineering • NASA Missions: Engineering Exploration	• Creativity and Innovation • Design for Manufacturability and Assembly • Earth, Moon, and Mars • Orbital Debris Mitigation and Reentry Risk Management** • Planetary Protection • Seven Axioms of Good Engineering • Space System Development: Lessons Learned		

PMI is a registered mark of the Project Management Institute, Inc.

**Also listed under Engineering (same course).

LEVELS OF PROJECT LEADERSHIP The levels of project leadership are guideposts as to when during an individual's career a course can be taken. Individuals should attend courses as they see fit to enhance competencies within their current positions, or for future development requirements.			
Examples of Positions (Read down for suggested courses)			
Team Practitioners/Technical Engineers	Subsystem Leads	Project Managers/Project Systems Engineers	Program Managers/Chief Engineers
EXAMPLES OF KNOWLEDGE-SHARING ACTIVITIES These are only examples; each center should identify experiences specific to their needs.			
• Obtain a mentor • Demonstrate working knowledge of agency policy documents • Benchmark and/or gather best practices to incorporate in your team's project • Attend a technical forum • Join national and international affiliations or technical bodies (e.g., INCOSE, Project Management Institute [PMI]®)	• Write and present a technical paper at an internal learning event • Attend a Knowledge Forum • Attend a non-NASA scientific or technical forum • Actively document and share lessons learned from your project/program	• Write and propose a technical paper for presentation at a forum • Lead a learning session at your center or directorate • Write and facilitate a case study	• Become a mentor • Conduct storytelling sessions • Instruct or become a guest speaker at Academy courses • Submit an article for possible publication in ***ASK Magazine*** or ***ASK News*** newsletter

CURRICULUM

Core Courses

Foundations of Aerospace at NASA (APPEL-FOU)

4.0 IACET CEUs

AUDIENCE: This course is designed for all NASA employees to educate them about NASA's strategic direction, its missions, governance structures, technical guidelines, and mission directorate programs and projects as well as NASA's past, present, and future.

GOAL: The goal of this 5-day learning experience is to immerse participants into the meaning of working at NASA and the principles of technical excellence. This aerospace foundations course provides the big picture overview of NASA, its governance model, and operations. The NASA leadership and various technical experts will provide insights into the organization and inner workings of the agency.

LEARNING OUTCOMES: You will gain an understanding of the basics of NASA's aerospace mission and systems, as well as the fundamentals of aeronautics and astronautics. You will better understand the NASA organization (including center activities), key programs and projects, and the agency's vision for exploration. You will explore the characteristics of effective teams and discover the value of effective technical communication and leadership. Additionally, you will be introduced to technical career development resources at NASA, particularly programs and activities sponsored by the Academy of Program/Project and Engineering Leadership (APPEL).

LEARNING METHODS: Learning will be accomplished through the use of lectures, videos, animations, and group exercises. A special aspect of the course includes discussions and activities with NASA leadership (from Headquarters and the centers), astronauts, and other noted NASA individuals. Learning activities include pre- and post-class assignments and reports.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain NASA's strategic goals and objectives as an agency, including its mission and governance model.
- Describe the "big picture" of NASA and how its infrastructure works.
- Describe the basics of NASA's space mission and systems, including aeronautics and astronautics concepts.
- Demonstrate effective technical communication skills and teamwork.
- Identify specific space exploration programs and projects and demonstrate the importance of space exploration to America.
- Explain the concept of systems thinking and associated trades.
- Explain trends in the space industry, space missions, and systems.
- Explain the fundamentals of orbits, maneuvering in space, interplanetary travels, and the space environment.
- Describe key aspects of payload and spacecraft design, launch systems, and space system operations.
- A solid foundation of aeronautics and space fundamentals, including concepts, vocabulary and applications
- A keen appreciation for the interdependence of the key elements that make up a space mission
- A "gut feel" for the complex trade-offs needed to develop a viable space mission
- An organized framework for future aerospace learning

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Agency structure and internal goals; communication/decision

making; team dynamics; aeronautics and astronautics concepts and terminology; aircraft design fundamentals; trends in the space industry; fundamentals of orbits, interplanetary travels, and the space environment; overall space system design and operations; basic aeronautics concepts; fundamentals of aircraft design; NASA project management and systems engineering policies and procedures.

ATTENDANCE: Enrollment and participation in this course is by center or organization nomination only. Please contact your Center Training and Development Officers and/or APPEL POC for more information on the nomination process.

Project Management and Systems Engineering (APPEL-PM&SE)

PMI® Course ID: PMSEA02 I 63 PDUs I 6.3 IACET CEUs

AUDIENCE: This course is designed for NASA project practitioners and systems engineers prior to or in the first year of entry into project, systems engineering, or supervisory positions.

GOAL: This eight-day on-site course (plus two-day equivalent of online work) is intended to enhance proficiency in applying PM and SE processes/practices over the project life cycle. The course focuses on defining and implementing system projects and provides valuable insight for managing and leading project and technical teams.

LEARNING METHODS: Learning will be accomplished using online material, lectures, group activities, and case studies. Working as a group, participants will prepare key PM and SE documents as part of an integrated group project.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe relevant NASA guidance on project management, systems engineering, and technical authority for specific project applications (NASA-smart).
- Explain the impact of project management and systems engineering challenges and decisions to safety and mission assurance across the mission life cycle (SMA-focused).
- Differentiate between the "art" and "science" of systems engineering.
- Apply each of the 17 processes contained within the "SE Engine" to specific system problems.
- Evaluate the disparate relationships and interfaces between system and project elements.
- Apply leadership principles to small-group dynamics to complete specific project management and systems engineering tasks.
- Differentiate approaches to PM and SE based on project scope.
- Create solutions to complex, ill-defined tasks including organizing, planning, executing, and adapting. ("mapping and managing") an integrated project plan, systems engineering management plan, and other tools for a representative space mission faced with real-world requirements to balance cost, schedule, performance, and risk across the life cycle.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Overview to project planning, WBS to schedule, resource loading to project budget, organizing for project management, managing stakeholder expectations, management information systems, systems engineering and project management, development and management of requirements, safety and mission assurance, life-cycle cost estimating, budget and budget strategy, acquisition and contract management, earned value management (EVM), technical risk and project risk management, leadership and teamwork, decisions and decision making, system design—defining stakeholder expectations and technical solutions, systems engineering management, realizing systems—implementing, integrating, verifying, validating, and transitioning the system.

ATTENDANCE: Enrollment and participation in this course is by center or organization nomination only. Please contact your Center Training and Development Officers and/or APPEL POC for more information on the nomination process.

RECOMMENDED PREREQUISITES: Foundations of Aerospace at NASA, or equivalent knowledge.

ACE Accreditation

Advanced Project Management and Advanced Systems Engineering (APPEL-APM&ASE)

PMI® Course ID: APMSE03 I 26 PDUs I 2.6 IACET CEUs

AUDIENCE: This course is designed as graduate-level seminar for experienced project managers (PMs) and systems engineers (SEs).

GOAL: This four-day course focuses on advanced concepts of project management and systems engineering and their integration in the management of all phases and facets of the project life cycle. This participant-driven course uses a case study approach to examine such topics as system architecting, performance, risk, cost, schedule, reliability, and operability, as well as stakeholder management and acquisition strategies.

The structured facilitation provides the context that frames advanced project management and systems engineering concepts used to describe practices, approaches, and issues. Participants will compare, differentiate, and discuss similarities, differences, and applications in order to draw conclusions on how to apply these concepts in their organization. This course equips participants with the knowledge necessary to realize successful project solutions, leveraging the unique roles and responsibilities of the project managers and the systems engineers put forth in NPRs 7120.5 and 7123.1.

LEARNING METHODS: Learning will be accomplished primarily through facilitated and structured class discussion on advanced systems engineering and project management topics. Introductory lectures on key course topics will preface each of the sessions. Utilizing NASA and industry case studies, attendees will then practice the "how to" of the principles through analyzing situations and applying concepts from the course to real project scenario exercises and illustrative examples. These practical exercises, complemented by the facilitated knowledge sharing that elicits senior level project experiences, will provide opportunities to consider and apply new techniques and decision processes required in real-world NASA project environments.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Manage the integration project management and systems engineering personnel functions to balance performance, risk, cost, schedule, reliability, and operability through all life-cycle phases per NASA policy guidelines.
- Apply techniques for coping with multiple stakeholders, complex approval situations, and teams drawn from across NASA.
- Manage the development of a system architecture compatible with the performance requirements, the organizations involved with that system, acceptable levels of risk, and suitable for the NASA mission to be performed.
- Direct the identification of system functional boundaries including multiple interfaces, segmenting the architecture into functions, and conducting functional analysis on all of the segments.
- Construct efficient acquisition strategies, lead their implementation, and monitor their effectiveness.

ATTENDANCE: Enrollment and participation in this course is by center or organization nomination only. Please contact your Center Training and Development Officers and/or APPEL POC for more information on the nomination process.

RECOMMENDED PREREQUISITES: Project Management and Systems Engineering (PM&SE), or equivalent knowledge.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project management and systems engineering integration; project planning; risk management; stakeholder management; project control; leadership; communication and decision making; system architecture; acquisition strategies and management; system design.

NOTES: The American Council on Education (ACE) has recommended that 2 transferrable graduate-level credits be awarded for the successful completion of this course.

ACE Accreditation

International Project Management (APPEL-IPM)

PMI® Course ID: 000005 I 43 PDUs I 4.3 IACET CEUs

BACKGROUND: The International Project Management course is organized by the NASA Academy with the support of NASA's partners in the International Project Management Committee (IPMC)* who contribute instructors for and who nominate project team members to participate in the course. The IPM course is held in February and July each year at the Academy Center for Excellence at Kennedy Space Center, with nominations for NASA participants

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* The IPMC is a group of more than 20 space agencies, companies, and research organizations from around the world that share experiences and best practices involving space project management.

solicited by a call to NASA Center Directors and Mission Directorate Associate Administrators.

AUDIENCE: This course is designed for program and project managers and project team members as well as others involved in or planning to work on international projects.

GOAL: The goal of this five-day course is to provide participants with an understanding of cultural challenges, ethical and legal concerns, and teaming issues likely to be encountered working on international projects. In addition, participants gain a first-hand appreciation of the approaches of several key NASA partners to managing joint projects and the challenges faced by project mangers in other countries.

LEARNING METHODS: Course materials and discussions provide insights into the characteristics of International teaming that have the potential to make or break a project. The course format features lectures, selected readings, small group discussions, hands-on practical exercises, and case studies. Instructors include experts on international cultural and ethical issues as well as experienced project managers from NASA, ESA, JAXA, and other agencies who discuss their experiences with participants. In addition, the participants have opportunities during the course for informal discussions with counterparts from other space agencies and organizations involved in the execution of collaborative projects.

SPECIFIC OBJECTIVES

- Upon completion of this course, participants will be able to:
- Recognize critical elements used in effectively managing projects with International partners.
- Describe significant issues that support or detract from team effectiveness when working with international partners.
- Recognize and appreciate the project management approaches of the European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA), and NASA as well as several other space agencies and companies who support them.
- Apply behaviors associated with the "softer" side of cross-cultural relations needed to be effective in the International Project Management arena.
- Explain the experiential and theoretical knowledge base that discriminates one culture from another.
- Discuss perceptual differences of "ethics" and how such differences can impact international team effectiveness.
- Recognize the legal, regulatory, and other management constraints that project teams must take into account in pursuing international projects.

COMPETENCIES AND TECHNICAL INFORMATION AREAS ADDRESSED: Interpersonal competencies associated with effectiveness in international negotiations and collaboration; major space agency's budget processes, programs, and plans; project management approaches, differences, and challenges in NASA, ESA, JAXA, and other space agencies; international legal and ethical differences; legal and management restrictions; several research bases for examining cultural differences.

NOTES: The American Council on Education (ACE) has recommended that 3 transferrable graduate-level credits be awarded for the successful completion of this course.

Project Management, Communication, and Leadership Courses

The Academy's program and project management training courses are designed to promote the conceptual and practical use of modern program/project management theories and applications throughout all phases of the NASA project life cycle.

Pre-Acquisition Analysis including Analysis of Alternatives (APPEL-AOA)

PMI® Course ID: AOA01 I 14 PDUs

AUDIENCE: This course is designed for experienced project and program managers, analysts, chief engineers, lead and senior systems engineers, cost estimators, risk analysts, and business group leaders.

GOAL: This two-day course addresses how analysis supports the major pre-acquisition decisions, as well as discussions of team structure, makeup, functions, and objectives. The course starts with operational mission gaps/shortfalls and follows through the major early investment strategy decisions. It introduces concepts and approaches for doing analysis as a logical foundation upon which to shape major investment decisions. It does not address specific models or tools, but rather the steps and analytical thought processes.

LEARNING METHODS: In addition to lecture, relevant case studies, exercises, and class dialogue, the course uses the participants' experiences to practice analysis scoping and planning.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain what the major early requirements/acquisition decision points are.
- Explain the elements of analysis needed to support early requirements/acquisition decisions.
- Illustrate the sequential, interdependent nature of the analysis process and the decisions it supports.
- Identify the major functional expertise and organizations needed to do pre-acquisition analysis.
- Discuss organizational dynamics as they aid/hinder good analysis.
- Describe some of the major strengths and limitations of analysis.
- Given a broad operational shortfall, construct a high-level analytic plan to evaluate options.
- Differentiate the roles of effectiveness analysis, cost analysis, and risk analysis in the broader pre-acquisition analysis.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Strategic thinking.

Pre-Acquisition Analysis including Analysis of Alternatives (APPEL-AOA-EXEC)

1.4 IACET CEUs

AUDIENCE: This course is designed for senior executives who will task, resource, or use the results of pre-acquisition analyses to form organizational requirements or decide what course of action to pursue to meet those requirements.

GOAL: This one to two-hour course addresses reasonable expectations executives can/should have for analyses supporting major organizational investment decisions. How analysis supports the major pre-acquisition decisions, as well as discussions of team structure, makeup, functions, and objectives. It is intended to improve communications between the executives and the analytic teams supporting them.

It introduces concepts and approaches for doing analysis as a logical foundation upon which to shape major investment decisions.

LEARNING METHODS: Briefing slides and relative real world examples used to guide the discussion and address the specific questions/issues the audience has. Generally this is given to small groups (notionally one to eight people) and in advance of the training it is highly tailored to the interests of the specific audience.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain what the major early requirements/acquisition decision points are.
- Explain the elements of analysis needed to support early requirements/acquisition decisions.
- Illustrate the sequential, interdependent nature of the analysis process and the decisions it supports.
- Identify the major functional expertise and organizations needed to do pre-acquisition analysis.
- Discuss organizational dynamics as they aid/hinder good analysis.
- Describe some of the major strengths and limitations of analysis.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Strategic thinking.

Assessing Project Performance (APPEL-APP)

PMI® Course ID: APP006 I 15 PDUs I 1.5 IACET CEUs

AUDIENCE: This course is for project managers, subsystem managers, and other project stakeholders responsible for meeting project commitments or who would benefit from understanding integrated project performance assessment techniques.

GOAL: During the two-days participants receive insights to how to manage and make informed decisions from the volumes of data available in projects. The sessions examine project performance from the technical (measures of effectiveness, measures of performance, technical performance measures, configuration management, and earned value); schedule (critical path, slack, and probability of completion); cost (earned value, estimates to complete, cost variances, and funding); and risk (probabilistic risk analysis, impact of discrete risks, and risk reserves or margin). Completion of the course enables an individual to interpret project information to understand status and predict project outcomes.

LEARNING METHODS: Lectures and discussions are combined with case studies, demonstrations, and exercises to maximize the learning experience.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Discuss the importance of project performance assessment.
- Develop a performance measurement structure.
- Apply performance assessment methodologies.
- Interpret the significance of project performance assessment results.
- Synthesize project performance data from multiple sources into a cohesive assessment of past, present, and future performance of the project.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Technical performance assessment, cost evaluation for budget, and full cost management; tracking and trending of project performance.

A basic understanding of earned value management methodology is suggested prior to taking this course.

Communicating Technical Issues (APPEL-CTI)

PMI® Course ID: CTI009 I 15 PDUs I 1.6 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel working on or leading project teams.

GOAL: This two-day workshop provides the foundation for communicating technical information to a varied audience and demonstrates effective methods and strategies for presenting technical issues.

LEARNING METHODS: This course provides hands-on experience in effectively communicating complex, technical information to different audiences, both those familiar with and those unfamiliar with the topic. Individual and small-group learning exercises will help you develop key communications competencies. In a laboratory setting, participants will structure and conduct presentations/meetings with stakeholders and project team members and establish a set of effective e-mail practices to use within a project.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe a basic communications model and apply it to different settings where technical information is required.
- Recognize the information and communication needs of diverse groups (e.g., project stakeholders, team members, review teams).
- Design and deliver technical communications using different media (e.g., meetings, presentations, e-mail).
- Present (in oral and written form) complex, technical material that is carefully tailored to specific audiences and that facilitates understanding.
- Solicit feedback and information as you present technical concepts and reports.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Communication and decision making, stakeholder management.

Crucial Conversations (APPEL-CC)

PMI® Course ID: CC01 I 14 PDUs I 1.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel working on or leading project teams.

GOAL: This two-day course teaches skills for creating alignment and agreement by fostering open dialogue around high-stakes, emotional, or risky topics—at all levels of your organization. By learning how to speak and be heard (and encouraging others to do the same), your organization will begin to surface the best ideas, make the highest-quality decisions, and then act on those decisions with unity and commitment.

LEARNING METHODS: Lectures and discussions will present key theories, concepts, and proven practices related to technical writing. Participants will take part in individual and small-group learning exercises to help develop skills and competencies. Participants will also put this knowledge to work by writing technical/project reports such as technical assessments, technical evaluations, and work-in-progress status reports.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Utilize a powerful approach to confidently and skillfully handle difficult conversations that can arise in

professional and personal lives.

- Resolve disagreements and accurately address concerns by talking respectfully, candidly, and skillfully with someone in a safe way.
- Build acceptance rather than resistance and give and receive feedback in a way that enhances relationships and improves results.
- Discuss how to speak persuasively, not abrasively such to effectively talk about high-stakes, emotional and controversial topics.
- Illustrate how to foster team work and get the right people involved in a way that ensures better decision-making and guarantees commitment and conviction.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Team dynamics and management, communication, and stakeholder management.

ACE Accreditation

Leading Complex Projects (APPEL-LCP)

PMI® Course ID: LCP015 I 21 PDUs I 2.1 IACET CEUs

AUDIENCE: This course is designed for experienced project managers who are subsystem leads or managers of small projects and are preparing to perform as project managers of more complex projects (multiple distinct subsystems, or other defined services, capabilities, or products) with associated interfaces.

GOAL: This three-day course provides participants with key project management concepts, tools, and techniques used to manage complex projects successfully. It also provides insights and tools to measure project complexity and adopt the best techniques for ensuring control of a project and all its associated elements.

LEARNING METHODS: This course is a progressive, integrated case study that enables participants to determine the true level of project complexity, and to lead a project team from a new perspective.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Clearly recognize how to address variables involved in dealing with complex projects.
- Master techniques for accurate work estimating and risk analysis in complex situations.
- Create a plan that provides the right level of control and flexibility for success in complex projects.
- Integrate strategic planning techniques to meet NASA requirements for complex projects.
- Recognize techniques for dealing with multiple stakeholders, complex approval situations and teams drawn from across the agency's organizational boundaries.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Risk management, project planning, stakeholder management, tracking and trending of project performance, project control, leadership, communication and decision making.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

Negotiations (APPEL-NG)

PMI® Course ID: NEG018 I 14 PDUs I 1.4 IACET CEUs

AUDIENCE: This course is designed for members of NASA's technical workforce, including systems engineers and project personnel, who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This two-day workshop identifies and develops the negotiating and bargaining skills necessary to successfully execute a win-win negotiation. Thorough instruction is provided on how to develop negotiating skills that promote effective leadership.

LEARNING METHODS: This highly interactive workshop uses a variety of instructional methods. Methods include tailored case studies, interactive facilitation, Q&A sessions, and other nontraditional techniques. Participants will take part in increasingly demanding negotiations and use impact and influence skills to persuade others to agree in both one-on-one and team exercises.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Construct creative, mutually satisfactory win–win solutions.
- Analyze available negotiating tactics and select strategies that can move the situation to your advantage.
- Establish and maintain a positive negotiating climate and effectively handle emotional situations.
- Overcome impasses by structuring creative options.
- Set desired outcomes, goals, bottom line targets, and alternative outcomes and options.
- Relate the difference between positions, interests, and fears.
- Overcome natural reluctance to negotiate, and reduce stress levels in the negotiation process.
- Use creativity and value-based negotiating to help achieve successful closure.
- Recognize how to manage ego and trust issues.
- Effectively manage team/staff negotiating situations.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Acquisitions management, contract management, leadership, team dynamics and management.

Orbital Debris Mitigation and Reentry Risk Management (APPEL-ODM)

1.5 IACET CEUs

AUDIENCE: This course is designed for NASA project practitioners, mission members, engineers, scientists, and other project support staff who are involved in spacecraft design and operations and interested in orbital debris issues and employing mitigation approaches, including "design for demise."

GOAL: This two-day course introduces participants to orbital debris environment characterization and mitigation, including characterization and future growth of the orbital debris environment; collision risks; and orbital debris mitigation policies, processes, requirements, and standards. It also explains reentry risks and design for demise methodology, including the origin and nature of NASA Human Casualty Reentry Risk assessments and criterion; overviews and applications of NASA Debris Assessment Software (DAS) and Object Reentry Survival Analysis Tool (ORSAT); design for demise objectives and experience; and demonstration of DAS reentry risk assessment.

LEARNING METHODS: Learning will be accomplished through lectures, specialized

software tool demonstrations, and mini-case studies of real world examples.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify the characteristics of the orbital debris environment and its sources.
- Describe various measurements in low-Earth orbit (LEO), medium-Earth orbit MEO, and geosynchronous orbit (GEO); explain orbital debris modeling methods; and explain collision risk probabilities and assessments.
- Describe orbital debris mitigation policies at the agency, national, and international levels.
- Explain the nature of NASA's Human Casualty Reentry Risk Assessments and Criterion.
- Describe the NASA Reentry Risk Evaluation Process, per NASA Standard 8719.14 requirements.
- Explain the benefits of DAS and ORSAT reentry assessment tools.
- Define the objectives for "design for demise" philosophy.
- Identify implementation design for demise strategies on specific NASA missions, including GPM, GLAST, RBSP, and Commercial Orbital Transportation Services (COTS).

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Orbital debris environment classifications, reentry risk assessments, design for demise, NASA orbital debris mitigation policies and requirements, collision risk probabilities and assessments.

Passing the Project Management Professional (PMP)® Exam (APPEL-PMP)

AUDIENCE: This course is designed for individuals seeking the Project Management Professional (PMP)® certification.

GOAL: This three-and-a-half-day course will acquaint the student with the 44 Project Management Institute (PMI)® processes, their inputs, tools, techniques, and outputs that comprise approximately 80 percent of the PMP® exam. It will also give the student the opportunity to become acquainted with the significant amount of material on professional responsibility and human resources that is not covered in PMI®'s *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*.

LEARNING METHODS: The large amount of material to be absorbed requires that the material be presented in a variety of ways. In addition to conventional lecture, the participants will act in skits, participate in games, see videos, hear effective jingles and poems, and use other mnemonic, interactive-learning techniques. Participants will take notes using color-coded pens that will match a large colored chart they receive. The presentation will address all learning styles.

QUALIFICATIONS FOR THIS COURSE: Interested students are encouraged to contact the instructor (Chris Bart) in advance to determine if they qualify to register for and attend this course.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be eligible to:

- Be guided personally through the application process for PMI®'s PMP® examination.
- Be counseled in advance to ensure that they are qualified to sit for the 200-question, four-hour PMP® exam.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project conceptualization; resource management; project implementation; delivery, operation, and closeout; program control and evaluation; human capital management; safety and mission assurance; professional and leadership development; knowledge management.

Performance-Based Statement of Work (APPEL-PBSOW)

PMI® Course ID: S20008 I 12 PDUs I 1.2 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel developing the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This two-day course will show you how to write an effective Performance-Based Statement of Work (PBSOW). You will understand what is meant by performance-based contracting and discover the advantages of this contract methodology.

LEARNING METHODS: Learning is accomplished through instructor-lead sessions using slides and flip charts. Students follow along using a detailed course package that is provided as part of the seminar. Students are encouraged to provide examples and "war stories" from their experiences.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define and describe performance-based contracts.
- Describe the advantages of PBSOW as opposed to a level-of-effort (LOE) statement of work.
- Identify the characteristics of both good and bad performance-based contracts.
- Analyze a given situation to establish the necessary requirements.
- Write SOW requirements that are clear and measurable.
- Demonstrate how to give contractors flexibility and authority while still holding them responsible.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Acquisition management.

ACE Accreditation

Project Acquisition Workshop (APPEL-PAW)

PMI® Course ID: APPEL-PAW I 20 PDUs I 2.0 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including project managers, subsystem leads, resource managers, contracting officers' technical representatives, and technical engineers who must deal with project-related acquisitions and procurements.

GOAL: This two-and-a-half-day course provides a basic understanding of the NASA acquisition/procurement process across the complete project life cycle, from agency strategic planning to contract management and project completion. This course will help participants figure out the optimal acquisition/procurement strategy, learn how to get contracts awarded, solve problems during contract performance, understand their roles and responsibilities as members of a project's acquisition team, work more effectively with contracting officers, and enable them to do a more effective job acquiring whatever their projects need to succeed.

LEARNING METHODS: The learning methods include lectures, discussions, group exercises (both large and small), lessons learned, and war stories. The course is designed around a twelve-part case study, based on a theoretical NASA flight project that illustrates all aspects of project acquisition. The lectures and examples are all derived from contracts associated with a variety of NASA projects.

SPECIFIC OBJECTIVES: Upon completion of the course, participants will be able to:

- Define, develop, explain, propose, and implement acquisition strategy.
- Analyze and translate the confusing world of procurement laws, regulations, and policies; recognize and apply the concept of "contract scope;" and operate more effectively with contracting officers.
- Plan for and implement project-related acquisitions, selecting the optimal procurement strategy and the type of contract most appropriate for the project.
- Define and identify the relation between project technical requirements and the acquisition process.
- Plan, organize, and manage the contract solicitation, evaluation, and selection processes.
- Establish and manage a project acquisition team, including the roles

of COTRs (contracting officer's technical representative), project managers (PMs), and contracting officers (COs), and monitor and evaluate contractor progress.

- Identify, analyze, and solve the numerous problems that inevitably occur during contract performance.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Acquisition management, contract management.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

ACE Accreditation

Project Management Leadership Lab (APPEL-PM-LAB)

PMI® Course ID: PMLAB19 I 34 PDUs I 3.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This four-and-a-half-day course is an intensive experience aimed at building capabilities needed to achieve project team objectives and to synthesize the project management practices learned through previous practice and study. This laboratory provides a unique opportunity to identify, understand, and practice effective leadership behaviors in a project team setting.

LEARNING METHODS: The Project Leadership Lab is a highly interactive experiential program design. Developed from more than thirty years of applied research and continuous user input and innovation, the program is anchored by a complex computer simulation exploring a project launch—employing multiple decision tree scenarios that activate dynamic variations and realistic outcomes. As part of a small team, participants are responsible for implementing a computer-simulated project. Participant teams collectively confront and resolve an array of problems associated with tasks, vendors, consultants, time, quality, customer interactions, and staff with varying personalities, skills, and experience.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Lead in ambiguous, complex environments.
- Develop adaptive leadership skills: recognizing when to focus on technical versus adaptive problems.
- Create defensible, flexible plans.
- Employ effective leadership techniques and improve interpersonal effectiveness.
- Manage risks.
- Identify complex project trade-off decisions.
- Lead and improve project team performance.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project proposal, requirements development, project planning, cost estimating, risk management, budget and full cost management, systems engineering, contract management, project control, team dynamics and management, mentoring and coaching, leadership.

NOTES: The American Council on Education (ACE) has recommended that 3 transferrable graduate-level credits be awarded for the successful completion of this course.

Project Planning Analysis and Control (APPEL-PPAC)

PMI® Course ID: FOU150 I 34 PDUs I 3.4 IACET CEUs

AUDIENCE: This course is designed for NASA's new engineers or early-career hires.

GOAL: This five-day course offers a foundation in program planning, analysis, and control, and provides intensive instruction in project management fundamentals across the entire project life cycle. Course content covers the areas of technical integration of project elements, design and discipline functions, and their associated interactions to balance performance, cost, schedule, reliability, and operability. Proven strategies and practical tools for planning, executing, and controlling a variety of projects are presented.

LEARNING METHODS: Individual and small-group learning exercises will help participants master key theories, concepts, and practices and put this knowledge to work in the classroom through a comprehensive case study and other practical learning activities.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define a project, its objectives, and measurement criteria for success.
- Estimate project schedules, costs, and resources using a variety of proven methods such as Earned Value Management.
- Build a work breakdown structure of project tasks.
- Define a network diagram and calculate the project schedule using PERT/Critical Path Method (CPM).
- Describe project risk identification, risk assessment, and risk mitigation strategies.
- Close out a project in a systematic, comprehensive manner.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Budget and full cost management, project control, requirements development, project planning, risk management, project review processes and strategies.

Project Scheduling: Basic and Advanced Concepts (APPEL-PSCHED)

PMI® Course ID: PSCHED01 I 14 PDUs I 1.4 IACET CEUs

AUDIENCE: This course is designed for project team members who are responsible for planning, controlling, and analyzing cost, schedule, and technical performance of an activity, project, or contract.

GOAL: This two-day course establishes how to develop, update, and maintain a project schedule and subsequently builds upon the foundational scheduling processes of activity definition, activity sequencing, activity duration estimating, schedule development, schedule status accounting and data maintenance, and schedule performance reporting to more advanced topics such as schedule analysis, schedule control (baseline revisions, re-planning, and workaround planning), and schedule reserve planning.

LEARNING METHODS: Lectures and discussions are combined with case studies, demonstrations, and exercises to maximize the learning experience.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Discuss the purpose and benefits of the project schedule.
- Recognize basic scheduling concepts and terminology.
- Illustrate how to identify activities, define project logic, estimate activity duration, and calculate "early" and "late" start and finish dates for the project's activities to establish the schedule baseline.
- Explain the significance of the critical path, total slack, and schedule reserve.
- Recognize various schedule reports and formats.
- Employ ways to assess when a project is likely to finish.
- Assess if the schedule is realistic.
- Appraise the significance of past schedule performance and trends.
- Evaluate the effect of changes on the baseline and current operating schedules.
- Assess the adequacy of schedule reserve and slack.
- Identify risk in the schedule.
- Recognize how to control the

schedule (including methods to accelerate the schedule or get back on track if behind plan).

- Differentiate between schedule baselines, re-baselines, revisions, re-plans, and workaround plans.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project control, tracking and trending of project performance.

Risk Management I (APPEL-RM I)

PMI® Course ID: RM022 I 7 PDUs I 0.7 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This one-day course enhances knowledge of NASA's approach to managing risk, and demonstrates the impact risks have on meeting program and project objectives. It provides an introduction to both the Risk Informed Decision Making (RIDM) and Continuous Risk Management (CRM) in the context of the policies and recommended practices that guide their application.

LEARNING METHODS: Lectures and interactive discussions supported by exercises, multimedia, and NASA-specific case studies provide practical insight to the application of the principles.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe NASA's risk management policy.
- Analyze NASA risk management processes as defined by the Risk Management Handbook.
- Explain individual roles and responsibilities for identification and management of risks.
- Explain the purpose and application, and illustrate the steps and implementation of risk-informed decision making.
- Explain the relationships between project decisions and project risks.
- Explain the purpose and application, and illustrate the steps and implementation of continuous risk management.
- Identify sources of risks and circumstances that may result in risks.
- Evaluate the risk management requirements for a project or program.
- Formulate an appropriate risk management approach in a risk management plan.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Technical risk management, risk management.

NOTES: The course design integrates two complimentary risk management processes: Risk Informed Decision Making (RIDM) and Continuous Risk Management (CRM).

Risk Management II (APPEL-RM II)

PMI® Course ID: APPEL-RM II I 14 PDUs I 1.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This two-day course builds on the knowledge of NASA's approach to managing risk provided in RM I. It provides an opportunity to evaluate and practice application of the Risk Informed Decision Making (RIDM) and Continuous Risk Management (CRM) in the context of NASA projects and programs.

LEARNING METHODS: Attendees use a threaded case study to perform all elements of the risk management process within a systems engineering context and following the guidance in the NASA Risk Management Handbook (NASA/SP-2011-3422 V1.0). Analysis and discussion of each step prepares attendees for determination of the key considerations for application on projects and programs in their home organization.

SPECIFIC OBJECTIVES: Upon completion of this course participants will be able to:

- Describe a process for reconciliation of divergent stakeholder objectives.
- State risk models appropriate for selected Performance Measures.
- Explain a probabilistic evaluation of alternative solution performance projections.
- State the content of a Technical Basis for Deliberation (TBfD) for inputs to decision analysis.
- Evaluate performance commitments for selected alternatives given stakeholder risk tolerances.
- Clearly state for the decision maker the advantages and disadvantages of alternatives from a risk informed decision making perspectives.
- Design the RIDM process into the requirements management baseline development.
- Assess identified risks to determine their tactical and strategic importance to prioritize for management action.
- Compare and contrast the differences between individual and aggregate risks.
- Use a graded approach to develop workable models for aggregate performance risks.
- Examine risk drivers for identified risks and their impact on the integrated risk model.
- Apply risk planning methods and techniques to develop specific risk handling actions.
- Evaluate tracking data to determine whether risk responses are implemented and effecting the anticipated changes in targeted risk drivers and performance risk Assess the impact of specific risks to program objectives.
- Recommend documentation and reporting characteristics for risks.
- Describe the advantage, use, and application of database tools for the capture, tracking, and reporting of risks.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Technical risk management, stakeholder management.

NOTES: The course design integrates two complimentary risk management processes: Risk Informed Decision Making (RIDM) and Continuous Risk Management (CRM).

Scheduling and Cost Control (APPEL-SCC)

PMI® Course ID: SCC023 I 28 PDUs I 2.8 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This four-day course focuses on managing project constraints including limits on time, human resources, materials, budget, and specifications. It also helps participants to develop effective measures for scheduling and controlling projects as they put the tools of project management to work.

LEARNING METHODS: Participants will get hands-on experiences practicing skills in building project requirements and

the work breakdown structure. Individual and small-group exercises feature scenarios that hone competencies and skills, and a comprehensive tool kit provides practical field guidance.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify documentation needed to provide inputs to scheduling and cost-control activities.
- Use the work breakdown structure to develop a network diagram.
- Calculate schedules using PERT/ Critical Path Method (CPM).
- Identify, assign, and tabulate resource requirements.
- Predict costs and work time using specific levels and estimate types.
- Plan for contingencies and anticipate variations.
- Estimate future project performance based on historical data.
- Monitor changes and close out projects on time.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project planning, cost estimating, project control, project review and evaluation, budget and full cost management, NASA project management procedures and guidelines.

Strategic Thinking for Project Success (APPEL-STPS)

PMI® Course ID: APPEL-STPS I 23 PDUs I 2.3 IACET CEUs

AUDIENCE: This course is designed for experienced project and program managers, chief engineers, lead and senior systems engineers, and business group leaders.

GOAL: This three-day course introduces concepts and methods for using strategic thinking as a logical foundation upon which to shape project definition and management.

LEARNING METHODS: In addition to lecture, relevant case studies, and class dialogue, the course uses the participants' experiences to practice hands-on strategy development.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain the elements of strategy.
- Illustrate an extended enterprise using a systems diagram.
- Analyze project current reality to determine contribution to strategic objectives.
- Create a project vision statement that focuses project strategic thinking.
- Define Key Performance Parameters tied to the strategic objectives.
- Interpret organizational dynamics in a strategic context.
- Create a strategic decision model using systems thinking.
- Identify and implement relevant performance guideposts.
- Evaluate project outcomes based on strategic performance.
- Evaluate a project for possible termination when it will no longer achieve its strategic objectives.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Strategic thinking, systems thinking.

Team Leadership (APPEL-TL)

PMI® Course ID: TL0024 I 17 PDUs I 1.7 IACET CEUs

AUDIENCE: This course is designed for NASA's technical and administrative workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This three-day workshop is aimed at building capabilities for managing and facilitating team processes necessary to achieve successful team performance. Concepts, processes, and practices for developing and managing superior teams are shared, and opportunities to practice and sharpen team leadership skills and competencies are part of the course content.

LEARNING METHODS: This workshop provides a venue for learning new concepts and for sharing successful and unsuccessful strategies for leading teams. Role-playing and small group activities reinforce learning. Lecture and both small and large group discussions allow participants to share experiences and benefit from the experiences of others.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Distinguish between leadership and management functions within project teams.
- Adjust leadership style to meet the demands and requirements of different situations and groups.
- Define and implement open and integrated communication approaches within and between teams to improve the interaction of the team members, increase buy-in, and enhance performance.
- Build a cohesive team and establish common standards for performance and quality.
- Motivate team members to pull together to accomplish goals.
- Systematically solve problems and resolve conflicts within the team.
- Ensure that agreed-upon plans are implemented.
- Capture and apply lessons learned and best practices.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Team dynamics and management, mentoring and coaching, communication and decision making.

Team Membership (APPEL-TM)

1.4 IACET CEUs

AUDIENCE: This course is designed for NASA's new engineers or early-career hires.

GOAL: This two-day workshop provides information on team dynamics, processes, roles/responsibilities, and other practical information for working effectively within a team environment. You will learn the strategies of how to be an effective member of a team and have opportunities to put these strategies into practice.

LEARNING METHODS: This course combines lectures and discussions to present the key concepts and proven practices that increase team collaboration. Individual and small-group learning exercises are used. Additionally, you will put this knowledge to work by participating in role-playing activities and other practical and stimulating learning experiences.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Recognize the importance of teamwork and participating in team activities at NASA.
- Define and describe different roles and responsibilities of team members on a project team and how they impact team performance.
- Identify and practice the characteristics of a superior NASA project team.
- Use an understanding of group dynamics to be an effective NASA team member.
- Apply team processes including collaborative decision-making, problem-solving methods, and conflict resolution approaches within or among teams.
- Appreciate being open to diverse viewpoints to achieve team success.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Collaboration skills, team dynamics.

Technical Writing for Engineers (APPEL-TW)

0.7 IACET CEUs

AUDIENCE: This course is designed for NASA's new and experienced engineers.

GOAL: This one-day workshop provides intensive instruction in technical writing to assist participants in improving technical communication skills, enabling them to effectively communicate technical/project information to different audiences.

LEARNING METHODS: Lectures and discussions will present key theories, concepts, and proven practices related to technical writing. Participants will take part in individual and small-group learning exercises to help develop skills and competencies. Participants will also put this knowledge to work by writing technical/project reports such as technical assessments, technical evaluations, and work-in-progress status reports.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify and explain the purpose of different types of technical reports.
- Recognize specific components and formats of technical reports.
- Analyze the audience.
- Organize and structure a technical report.
- Write effective headings, factual information/detail, and technical content.
- Create clear figures/tables.
- Recognize and avoid the common pitfalls of writing technical reports.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Communication and decision making, stakeholder management.

Project Management: Earned Value Management (EVM) Courses

Advanced Earned Value Management (APPEL-AEVM)

PMI® Course ID: APPEL-AEVM I 14 PDUs I 1.40 IACET CEUs

AUDIENCE: This is an advanced course that is designed for project team members and others who are responsible for the cost, schedule, and technical performance of project work scope to include performance of suppliers, contractors, and partners.

GOAL: This two-day course will provide a working level understanding of how to manage changes to the Performance Measurement Baseline (PMB), control management reserve, and analyze performance indicators and flags that build upon the basic understanding of EVM and the PMB, cost and schedule variances and indices, and estimate at completion (EAC).

LEARNING METHODS: Lectures, discussions, exercises, and a case study will present key project management concepts of planning, executing, and control using the EVM process.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain how to manage changes to the PMB.
- Demonstrate proper use of management reserve and schedule margin.
- Validate EVM and schedule data; interface with suppliers about performance reporting; and formulate action plans.
- Recognize and respond to early warning signs from EVM data analysis and use results for effective decision making.
- Develop independent estimates at completion based on historical performance.
- Formulate pertinent EVM metrics and reporting for senior management.
- Explain the role of EVM in the contractor performance evaluation and award fee process.
- Describe methods to build good EVM working relationships between the customer and their suppliers.

RECOMMENDED PREREQUISITE: Understanding EVM (UEVM).

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Earned value management.

NOTES: Please refer to the Academy web site for PMI® PDU information.

Control Account Manager (CAM)—Online Discussion

AUDIENCE: This Humphreys and Associates discussion course is designed for anyone anticipating an Integrated Baseline Review or Surveillance Review.

GOAL: The goal of this two-hour online video is help prepare students for a customer Integrated Baseline Review (IBR), compliance review, or surveillance review.

LEARNING METHODS: Discussion course represents a typical interview of a CAM during a government review. It also assesses the CAM's use and understanding of an organization's EVMS. The discussion covers all EVMS processes of an organization's system as they pertain to a CAM.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Provide a realistic simulation of a

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Developed and taught by NASA-experienced EVM practitioners for NASA program and project teams, the EVM curriculum provides a framework for understanding this dynamic integrated project management methodology.

Recent changes to the NASA EVM requirements make it imperative that NASA project personnel develop an in-depth knowledge of EVM. Within the government, the Office of Management and Budget (OMB) continues to require EVM on government projects for both in-house and contracted efforts. In addition, the Government Accountability Office (GAO) conducts annual audits of NASA projects to determine whether NASA projects have implemented EVM appropriately and are using the data to make management decisions. Internally, NASA recently updated its NASA Procedural Requirements (NPR) 7120.5 NASA Space Flight Program and Project Management Requirements, to include increased EVM requirements for projects. The new requirement is that NASA projects shall comply with the standards listed in American National Standards Institute/Electronic Industry Alliance-748-B (ANSI/EIA-748-B) Earned Value Management Systems.

The previous requirement was to comply with the EVM principles which are a much lower standard than the 32 guidelines listed in the ANSI/EIA-748. This new requirement is for both in-house and contracted efforts, to include consolidating the in-house and contracted data into overall project EVM reporting. To support projects with this requirement, NASA has developed an EVM Capability process. The EVM Capability process and all supporting documentation can be used by any NASA project that has the EVM requirement. The use of the internal EVM process will ensure NASA projects are compliant with the requirements without having to develop a new process.

The EVM Capability process documentation can be found on the NASA Engineering Network web site at https://nen.nasa.gov/web/ll/home under the community's button by following the Earned Value Management link and document repository tab. For center or project-specific assistance, you can contact your center's EVM Focal Point at http://evm.nasa.gov/fpcpocs.html. The NASA EVM web site at http://evm.nasa.gov has additional information to assist NASA projects with resources they may need in regards to EVM.

typical CAM documentation review and interview session.

- Demonstrate how a well prepared CAM successfully conducts an interview with a government customer.
- Provide key technical points and suggestions for follow up action items in a CAM interview.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Earned value management.

Earned Value Management Systems (EVMS)—Online Training Course

AUDIENCE: This course is designed for project team members who are responsible for planning, controlling, and analyzing cost, schedule, and technical performance of an activity, project, or contract.

GOAL: This 40-hour online training courses introduces the standards, objectives, policies, and procedures embodied in the EVM system by the government customer. It also presents the background of EVM, and provides context that explains why the guideline exists and why systems are implemented by contractors.

LEARNING METHODS: Videos, interactive case studies, and quizzes.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Understand the government policy and benefits for a single contractor unique system meeting a basic set of 32 guidelines.
- Review list of government acquisition management policies concerning EVM Systems applications.
- Become aware of various government thresholds requiring EVM Systems.
- Understand some of the background and history of the development of EVM Systems.
- Understand that cost, schedule, and technical risk determine the system tailoring to fit management of a specific program.
- Become aware of the need to balance the cost of maintaining a performance measurement system with its application benefit of reducing program risks.
- Understand the data element requirements and the five areas of system implementation and maintenance.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Earned value management.

Integrated Baseline Review (IBR)—Online Training Module

AUDIENCE: This module is designed for government and contractor project teams that have some background in EVMS and will be conducting or participating in an Integrated Baseline Review (IBR).

GOAL: This two-and-a-half-hour online course module is to provide an overview of the Integrated Baseline Review process.

LEARNING METHODS: Humphreys and Associates Integrated Baseline Review (IBR) is an in-depth, practical tool that helps participants fully grasp the IBR process. Designed as a briskly paced presentation, the IBR is an important step in assuring that students understand the desired technical contents of a project and clearly establish schedule, cost, and performance goals using earned value management (EVM).

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Understand the definition of an IBR.
- Understand why and when IBRs are conducted.
- Comprehend the applicability of the IBR.
- Appreciate the basic differences between an IBR and a compliance evaluation.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Earned value management.

Scheduling Virtual Learning Lab—Online Training Course

AUDIENCE: The goal of this Humphreys and Associates course is designed for project personnel to enhance their project scheduling proficiency or for anyone who wants to learn the basics of project scheduling at their own pace.

GOAL: The goal of this 16-hour online course is to introduce students to topics such as critical path fundamentals, schedule baseline, float, network logic development, risk assessment, changes, and scheduling in an EVMS environment.

LEARNING METHODS: Videos, interactive case studies, and quizzes.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define scheduling, discuss the benefits of scheduling, and develop a proper schedule.
- Provide and demonstrate in detail the schedule development process, including logic networks, critical path method, display types, scheduling techniques, schedule risk assessment, baselining, statusing, schedule traceability, accelerating schedules, what-if analyses, etc.
- Provide key points to scheduling in a manufacturing environment.
- Understand scheduling and EVMS, performance measurement techniques, etc.
- Become aware of scheduling systems: tools, processes, and people.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project scheduling, project control.

Understanding Earned Value Management (APPEL-UEVM)

PMI® Course ID: APPEL-UEVM I 7 PDUs I 0.7 IACET CEUs

AUDIENCE: This course is designed for project team members that require a basic understanding of earned value management (EVM) and who may contribute to planning, controlling, and analyzing cost, schedule, and technical

performance of an activity, project, or contract.

GOAL: This one-day course will provide a high-level understanding of EVM concepts as well as techniques for analyzing EVM data.

LEARNING METHODS: Lectures, discussions, and exercises will present key concepts regarding the EVM process.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Recognize basic EVM concepts and terminology, and know how to interpret EVM reports and graphs.
- Explain the governing policies, requirements, and the American National Standards Institute/Electronic Industries Alliance - 748 (latest version), Earned Value Management Systems (ANSI/EIA-748) guidelines for EVM on NASA projects.
- Recognize the principles involved in establishing a performance measurement baseline (PMB), including: the role of the work breakdown structure (WBS) in defining scope; the value of developing a responsibility assignment matrix; the importance of the integrated master schedule; and the significance of tying the budget to the schedule with the WBS.
- Describe the earned value methods for discrete effort, apportioned effort, and level of effort.
- Recognize how to use performance indices and factors to calculate estimates of the final cost and variances from the baseline.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Earned value management basics.

NOTES: Please refer to the Academy web site for PMI® PDU information.

Systems Engineering Courses

The Academy's systems engineering curriculum provides training in systems engineering processes and tools and promotes experience-driven technical leadership development.

ACE Accreditation

Concept Exploration and System Architecting (APPEL-CESA)

PMI® Course ID: CESA30 I 36 PDUs I 3.6 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel.

GOAL: This four-and-a-half-day workshop introduces participants to the primary processes and tools for successfully performing up-front system engineering analysis. Participants learn how to define proper system scope, acceptance criteria, create context diagrams and develop use case scenarios, and synthesize a first-level logical architecture for the system to help meet customer objectives, requirements, and constraints. In addition, participants are introduced to the fundamentals of life-cycle cost analysis as well as risk management and other program issues.

LEARNING METHODS: The learning methods include lectures, discussions, group exercises, and other activities, including actual system engineering problems of all types, with an emphasis on NASA missions and systems.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain the rationale for and the value of systems engineering concepts and principles.
- Define various systems engineering-related terms and explain the systems engineering process.
- Describe the system life cycle and various systems engineering life-cycle models, phase gates, reviews, and standards.
- Apply the systems engineering process and principles from the identification of a customer or other stakeholder need through a System Requirements Review (SRR).

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Mission needs statement, stakeholder management, system architecture, technical requirements definition.

NOTES: Please note that this course is based on the Stevens Institute of Technology's "Fundamentals of Systems Engineering course (SYS 625)."

The American Council on Education (ACE) has recommended that 2 transferrable graduate-level credits be awarded for the successful completion of this course.

ACE Accreditation

Decision Analysis (APPEL-DA)

PMI® Course ID: APPEL-DA I 14 PDUs I 1.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel involved in project teams or small projects.

GOAL: This two-day course is designed to provide the tools necessary to improve the quality of a factually based decision-making process for resolving technical issues at NASA.

LEARNING METHODS: Case studies, small group applications, and informed discussions with knowledgeable resources will serve as the basis for course activities.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify Decision Analysis relationship to NPR 7123.1, NASA Systems Engineering Processes and Requirements, including role of Systems Engineering Management Plan (SEMP).
- Recognize factors contributing to successful and unsuccessful decision-making.
- Apply a standard process for decision-making.
- Identify which technical issues are subject to formal evaluation and discern the differences between a well-framed problem and a poorly framed one.
- Define the criteria used for evaluation and identify alternative solutions to address decision issues.
- Select evaluation methods and tools, and assess alternative solutions with respect to evaluation criteria.
- Make a decision, document, and evaluate decision impact.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Technical decision analysis, systems engineering, communication and decision making.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

Developing and Implementing a Systems Engineering Management Plan (APPEL-SEMP)

PMI® Course ID: SEMP11 I 22 PDUs I 2.2 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel developing the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This three-day course introduces participants to the processes that support planning, development, and execution of a Systems Engineering Management Plan (SEMP). Participants learn how to create a SEMP in compliance with NASA standards. In addition, they learn how technical planning complements the project planning to create the next-level guidance for a technical team. They learn how to schedule technical reviews, systems engineering activities, technology insertion, and detailed technical activities. They learn the importance of technical management in the execution of any project, and how to use technical leadership to keep a project on track.

LEARNING METHODS: Learning is accomplished through lectures, discussions, group exercises, and other activities, including case studies involving the planning, development, monitoring, and assessment of systems engineering activities using a SEMP. Cases emphasize NASA missions and systems.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe the importance of technical planning and technical management.
- Describe how the technical plan coordinates with a project plan.
- Document a technical plan in a NASA-compliant Systems Engineering Management Plan (SEMP).
- Explain the NASA procedural requirements (NPR 7123.1 for systems engineering and 7120.5 for project management) to create a technical plan.
- Define the technical work necessary and sufficient to complete a project.
- Describe the characteristics and elements of a good technical plan.
- Describe the flow of systems engineering activities that guide a project.
- Select appropriate technical reviews, metrics, and measurements to assess project progress.
- Explain how to use the SEMP to control scope during project execution.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project planning, systems engineering management.

ACE Accreditation

Fundamentals of Systems Engineering (APPEL-FSE)

PMI® Course ID: FSE031 I 35 PDUs I 3.5 IACET CEUs

AUDIENCE: This course is designed for junior to mid-career NASA systems engineers, functional engineers, project managers, integrated product team members, and business managers.

GOAL: This course introduces the methods and techniques for a structured systems development process that proceeds from requirements to concept to production to operation and is based upon NASA policy guidelines, specifically NASA Procedural Requirements (NPR) 7123.1 and 7120.5. The NASA practice of systems engineering is the glue across all engineering and project management disciplines that ties customer needs to the right solution. Systems engineering focuses on the interfaces between the people, processes, and products that are often outside the responsibility of any one function or discipline. This course equips your teams with the knowledge necessary to realize successful solutions.

LEARNING METHODS: Learning will be accomplished through lecture and class discussion. Attendees will practice the "how to" of the principles through case studies and illustrative examples. Practical exercises provide experience in the techniques and decisions required in a real world environment.

If the hands-on life-cycle activity option is selected, the participants will develop and present appropriate artifacts and content based upon a real NASA case study. This activity will be conducted post-course with guidance from the instructor.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain the purpose of systems engineering.
- Describe the systems engineering process incorporating NASA policy guidelines (NPRs 7123.1 and 7120.5).
- Explain the process for system requirements development and management.
- Describe the system definition process (concepts and architecting).
- Defend project decisions and trade-off analyses.
- Analyze product and project risk and mitigation based upon NASA policies and practices.
- Examine reliability, availability, and supportability factors during the design process.
- Explain performance measurement needs.
- Describe the system implementation process.
- Explain verification and validation activities.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Purpose of systems engineering; systems engineering processes incorporating NASA Procedural Requirements (NPRs) 7123.1 and 7120.5; system definition process (concepts and architecting); incorporating reliability, availability, and supportability considerations into the design process; system implementation process.

NOTES: The American Council on Education (ACE) has recommended that 2 transferrable graduate-level credits be awarded for the successful completion of this course.

Human Spaceflight and Mission Design (APPEL-HSMD)

2.1 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers and project personnel involved in creating overall mission architectures, detailed design and the operation of systems.

GOAL: This three-day workshop focuses on creating a phased, conceptual design for complete Earth-orbiting, lunar, and Mars manned missions. It provides an overview of human space exploration including the vision for the future, objectives and strategies, as well as a view of upcoming technologies and missions.

LEARNING METHODS: An integrated example of a Lunar Base Mission is used throughout the course to illustrate each of the design areas covered. This example enables hands-on, practical experience

in applying the information and tools provided. The course involves real-world design exercises aimed at helping participants apply the techniques and guidelines presented once they return to work. All participants receive a complete set of course notes and the new edition of the authoritative text Human Spaceflight by McQuade, Larson and Pranke.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Interpret and convert space mission objectives, requirements, and constraints into visible and cost effective operations concepts.
- Develop and apply hazards and mitigation techniques.
- Explain the physiology of space flight, human factors, and psychological aspects.
- Describe a process-oriented approach for creating cost-effective space missions.
- Describe the key functions that must be performed for mission operations.
- Apply effective methodology for translating space mission objectives, requirements, and designs into viable and cost-effective operations concepts.
- Explain the interrelationships and trade-offs between system design and mission operation.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Agency structure and goals, mission design, operations, system architecture,

ACE Accreditation

Life Cycle, Processes, and Systems Engineering (APPEL-LPSE)

2.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This three-day course introduces systems engineering processes, NASA life-cycle phases, key technical reviews, and systems engineering management techniques. The course helps you realize the value of well-established systems engineering processes and deliverables.

LEARNING METHODS: Lectures, discussions, exercises, and other activities including structured systems engineering processes and management undertakings enhance the learning experience.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define and demonstrate engineering of systems processes as illustrated in the NASA Procedural Requirements (NPR) for systems engineering (NPR 7123.1) and project management (NPR 7120.5).
- Explain operations concepts, their development, and their impact on the system of interest.
- Define system architecture functions and analyze their functional performance.
- Define system technical solution options and describe how trade studies are performed.
- Map architecture functions to subsystems and define the relationships among the subsystems.
- Describe internal and external interface definitions, designs, and changes for products and product components.
- Explain the importance of establishing a technical planning process for a given system of interest.
- Explain system realization, integration, verification, validation, and transition
- Identify tools used for systems engineering activities.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Project planning, NASA project management and systems engineering procedures and guidelines, systems engineering.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

Mars Mission and Systems Design Lab (APPEL-MMSD)

2.8 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers, and project personnel involved in creating overall mission architectures, detailed design, and the operation of systems.

GOAL: This four-day lab is designed to provide real-life experience conceptualizing and designing space missions to Mars or the moon. This lab provides an integrated view of space mission design and operations, from conceptual design and requirements definition through spacecraft design, development, test, and launch to development of mission operations concepts and ground infrastructure capabilities.

LEARNING METHODS: A variety of learning methods are used, including lecture, group discussion, exercises, and videos. Participants will be introduced to various demonstrations and exercises using a Satellite Tool Kit with a temporary full-use license. Hands-on exercises introduce the Space Mission Analysis and Design Software Tool, specifically tailored to Mars or the moon.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Demonstrate space systems engineering processes.
- Formulate development strategies for systems engineering management, technical integrity, and technical leadership.
- Assemble all the elements of a mission successfully through a process of integration.
- Set up a process to refine requirements and define parameters to meet mission objectives at acceptable costs and risk.
- Apply processes in a non-threatening environment.
- Apply systems-level thinking to projects.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Systems engineering, system architecture, mission design, operations.

Requirements Development and Management (APPEL-REQ)

PMI® Course ID: APPEL-REQ I 20 PDUs I 2.0 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This three-day course provides a firm foundation for the development and management of a project's product requirements. This course presents the participant with best practices that, when incorporated into the requirement development and management process, will help a project team develop a winning product—one that delivers what is needed, when it is needed, within the projected costs and with the expected quality.

LEARNING METHODS: Lectures, discussion, and individual and small-group learning exercises help participants

learn how to develop and manage product scope and requirements. Writing exercises and peer reviews reinforce and expand learning.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify the benefits of defining scope at the beginning of your product development process.
- Identify and describe the importance of drivers and constraints.
- Develop and describe the importance of operational concepts.
- Explain product scope, product validation, and baselining.
- Identify the characteristics of good and well-written requirements.
- Explain the levels of requirements, how requirements are linked, and the iterative nature of requirement decomposition.
- Explain the importance of allocation and how to allocate requirements.
- Identify types of requirements that must be defined and write good requirements.
- Describe the processes, activities, and tools that are used to manage requirements throughout the product life cycle.
- Describe management's role in requirements management activities.
- Explain how and why a requirements development and management process needs to be defined and followed.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Requirements development, logical decomposition, requirements management.

Requirements Development and Management—Team (APPEL-REQ-T)

2.0 IACET CEUs

AUDIENCE: This course is designed to meet the needs of intact project teams, including project managers, systems engineers, users, customers, developers, testers, and other relevant stakeholders. Anyone involved in the development, review, or management of project scope and system or product requirements for a project will benefit from this training. The seminar is applicable to projects large and small as well as hardware and software projects of all sizes.

GOAL: This three-day course provides a project team with just-in-time-training for the development and management of the project's product scope and requirements. During this course, the project's existing scope and requirements documentation are reviewed and used to allow participants to determine which areas need improvement and further work. The resulting effort is improved project scope, requirements, action items, and better communication between team members. This course will help the project team apply requirement engineering best practices necessary to develop a winning product—one that delivers what is needed, when it is needed, within the projected costs and with the expected quality.

LEARNING METHODS: Lectures, discussion, and individual and small-group learning exercises will help the project team learn how to develop and manage the project's product scope and requirements. Exercises are included based on the project's existing requirements allowing participants to improve their project's requirements as part of the seminar.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define a project's product need, goals, and objectives.
- Identify drivers and constraints.
- Develop and document operational concepts.
- Identify and define a product's external interfaces.
- Explain product scope, product validation, and baselining.
- Identify the characteristics of good and well-written requirements.
- Write requirements at the correct level and to link requirements.
- Correctly allocate requirements.
- Identify types of requirements that must be defined.
- Apply continuous and discrete requirement validation activities to remove requirement defects.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Requirements development, requirements management.

Science Mission Systems Design and Operations (APPEL-SMSDO)

2.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers, and project personnel involved in creating overall mission architectures, detailed designs, and the operation of systems.

GOAL: This three-day course provides an integrated view of space science mission design and operations from conceptual design and requirements definition, through spacecraft design, development, and test, to development of mission operations concepts and ground infrastructure capabilities.

LEARNING METHODS: Learning will be enhanced through lectures, group discussions, videos, demonstrations, and multiple team activities applying materials from previous NASA missions.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define the components and systems of a robotic space mission.
- Describe an integrated view of space science mission design and operations.
- Describe the interrelationships between systems design and mission operations.
- Describe a process-oriented approach for creating cost-effective space missions.
- Apply effective methodologies for translating space mission objectives, requirements, and designs into viable and economical operations concepts.
- Demonstrate practical, detailed ideas and tools to analyze and design space segment support for unmanned missions, including architecture and configuration, payloads, and vehicle subsystems.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Unmanned space missions, agency structure and goals, system architecture, mission design, operations.

Science Mission Systems Design and Operations—Lab (APPEL-SMSDO LAB)

3.1 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers, and project personnel involved in creating overall mission architectures, detailed designs, and the operation of systems.

GOAL: This four-day lab is designed to provide real-life experience for conceptualizing and designing space missions. The lab provides an integrated view of space mission design and operations, from conceptual design and requirements definition through spacecraft design, development, test, and launch to mission operations concepts and ground infrastructure design.

LEARNING METHODS: Participants will be given a bona fide, real-life mission objective and divided into competing groups or teams to conceptually design a mission to meet the objectives at an acceptable life-cycle cost. Participants will be introduced to various demonstrations and exercises using a Satellite Tool Kit with a temporary full-use license. Other learning methods include lectures, group discussions, demonstrations, and videos. All participants receive a complete set of course notes, the authoritative text Space Mission Analysis and Design by Larson

and Wertz, and an integrated software tool for performing detailed space mission design.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe and apply an integrated approach to space mission design and operations.
- Develop mission concepts and supporting architectures to meet specific mission objectives.
- Develop effective techniques for providing customers and stakeholders with space mission concepts and architecture in the most cost-effective manner possible.
- Apply an effective methodology for translating space mission objectives, requirements, and designs into viable and cost-effective operations concepts.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Systems engineering, system architecture, mission design, operations.

Space Launch and Transportation Systems (APPEL-SLTS)

2.4 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers, and project personnel involved in creating overall mission architectures, detailed designs, and the operation of systems.

GOAL: This three-day course is intended to provide practical, detailed approaches, and tools to analyze and design manned and unmanned and reusable and expendable launch vehicles for Earth and other planets. This includes architecture and configuration, payloads, and vehicle subsystems.

LEARNING METHODS: Lectures, discussions, group exercises, videos, and physical examples will increase participants' understanding of space launch and transportation systems.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify practical tools and processes for the analysis and design of manned and unmanned, reusable, and expendable vehicles for Earth and other planets.
- Describe a process-oriented approach for creating cost-effective space launch and transportation systems to meet broad, often poorly defined requirements.
- Apply effective methodologies for translating space launch and transportation system (SLTS) objectives, requirements, and designs into viable and economical operations concepts.
- Explain the components of space launch and transportation systems design and operations.
- Define the parameters for evaluating the life-cycle cost of space launch and transportation systems.
- Identify technical risks and mitigate them in the most cost-effective manner while maintaining the technical integrity of the vehicle(s) and infrastructure.
- Describe launch operations functions that must be performed.
- Describe the interrelationships and trade-offs between system design and mission operations.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Launch vehicles, system architecture, mission design, operations.

Space System Verification and Validation (APPEL-SSVV)

2.3 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including engineers, systems engineers, and project personnel involved in creating overall mission architectures, detailed designs, and the operation of systems.

GOAL: This three-day course demonstrates the processes, information, and tools necessary to implement a credible verification, integration, and test program. It provides exposure to NASA and Department of Defense (DoD) standards, lessons learned, tools, and experiences in validation and verification.

LEARNING METHODS: This course provides a hands-on system validation and verification learning laboratory. Lectures, small group exercises, and videos will also enhance the learning experience. Participants plan test campaigns, execute tests, integrate subsystems, and conduct test reviews using a unique desktop satellite called Eyasat.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain the end-to-end systems engineering process and its application to system (and lower level) requirements definition, allocation, validation, and verification.
- Describe the purpose and scope of key documents required in the validation and verification processes, and describe typical errors committed.
- Describe various methods of verification, and determine when they are appropriate and how they are used as part of a verification plan.
- Assess applicability of verification methods to prototype and protoflight systems.
- Describe capabilities of various automated requirements tracking tools (e.g., CORE and DOORS) and their applicability to the validation and verification process.
- Develop, evaluate, and implement a master verification plan for a space system, including hardware, software, and associated ground support equipment (GSE).
- Apply processes and techniques in a hands-on workshop associated with a system of interest.
- Identify applicable NASA, ECCS, DoD, and industry standards and lessons learned to support system verification decisions and activities.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Product verification, product validation.

Transition, Product Delivery, and Mission Operations (APPEL-TPDMO)

2.8 IACET CEUs

AUDIENCE: This course is designed for NASA's technical workforce, including systems engineers and project personnel who seek to develop the competencies required to succeed as a leader of a project team, functional team, or small project.

GOAL: This four-day course is intended to demonstrate the processes, procedures, and strategies necessary to implement

effective product development, transition, delivery, and operations.

LEARNING METHODS: Learning will be through lectures, discussions, group exercises, and activities such as actual product development, transition, and discussion of operations problems of all types (with an emphasis on NASA missions and systems).

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe the enabling processes for product development or acquisition.
- Describe the various activities/ strategies that support effective product implementation.
- Describe the evaluation process of enabling product readiness.
- Evaluate validation of lower level procured products and preparation of the environment for integration.
- Develop a plan for product integration.
- Identify the "active ingredients" of product integration documentation.
- Describe product verification and validation processes and how the outcomes are analyzed and reported, including all the support documentation.
- Identify the various documentations that support product transition.
- Identify product transition processes, procedures, and enabling product needs.
- Assess the value of operations planning and execution.
- Identify the processes for product operations.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Product implementation, product integration, product verification, product validation, product transition, product operations.

Engineering Courses

The Academy's engineering courses focus on engineering essentials, critical thinking, lessons learned, and space systems to strengthen NASA-specific engineering expertise and capabilities.

Essentials of Astronomy for NASA Engineers (APPEL-ASTRO)

2.2 IACET CEUs

AUDIENCE: This course is for NASA engineers and technicians who have minimal astronomy training and would like to gain a foundational understanding of the philosophical underpinnings and the "big picture" of astronomy.

GOAL: Most engineers earn undergraduate degrees without a foundational background in astronomy, yet their daily work at NASA is ultimately connected to cutting-edge exploration programs. This course offers participants a physical and philosophical understanding of our universe, allows them to more fully appreciate the scope of and rationale behind the work they are involved in, and inspires a continued interest in astronomy.

LEARNING METHODS: Fundamental knowledge of the universe and observational astronomy is achieved through lectures that include a wide variety of multi-media resources, together with thought-provoking interactive discussions. Key NASA programs that have proved invaluable to the astronomy community are also highlighted. An optional observation night is also offered in conjunction with this course, when possible, to tour the night sky.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Recall the high-level essentials of the history and science of astronomy, including findings by ancient philosophers, Newton, and Einstein.
- Explain the basics of observational astronomy, including the calendar, seasons, and eclipses.
- Describe the physical creation, elements, timeline, scale, and physical evolution of the universe, solar system, stars, galaxies, and other astronomical bodies, as well as explain its current state and ultimate demise.
- Discuss various resources leveraged for space studies (telescopes, spacecraft, remote-sensing instruments, etc.) and differentiate their intended uses.
- Develop a deeper appreciation for the majesty of the worlds explored through engineering abilities, and defend the importance of NASA exploring the universe.
- Use, as an engaged hobbyist, recommended astronomy hardware, software, and educational tools and resources to continue learning about the universe.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: High-level history and science of astronomy; basics of observational astronomy; creation of the universe, its current state, and ultimate demise; different uses of various space studies scientific instruments and spacecraft.

Creativity and Innovation (APPEL-CREATE)

1.6 IACET CEUs

AUDIENCE: This course is for NASA's technical and managerial workforce, including engineers and program personnel, who are seeking to increase their abilities to be both creative and innovative in their technical and managerial endeavors.

GOAL: "The excessive focus on analysis, targets, and number crunching, and the

absence of introspection and imagination has resulted in a crisis in management" (Henry Mintzberg, The Globe and Mail, March 16, 2009). This course seeks to address this crisis. The goal of this course is to enable NASA personnel to be more creative and innovative in all their works, including technical and managerial. Participants will learn what enables creativity and innovation as well as what hinders it. Participants will learn techniques and tools that they can employ in their everyday work that will enable themselves and their coworkers to be more creative and innovative.

LEARNING METHODS: This is a highly interactive course utilizing active learning and project based learning techniques. Minimal formal lecture presentation (e.g., PowerPoint) is included. The pedagogy employed uses brief mini-talks that introduce new concepts and that question common assumptions about creativity and innovation. These mini-talks are followed by group discussions and then either implementation exercises or projects. Exercises and projects are conducted in class by small groups of participants.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Define, employ, and assess creativity.
- Define, employ, and assess innovation.
- Apply creativity and innovation techniques to address technical, process, and managerial challenges.
- Define and utilize whole brain thinking.
- Practice structured and unstructured brainstorming techniques.
- Motivate and enable creativity and innovation in their coworkers.
- Recognize and assess inhibitors to creativity and innovation.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: The ability to be more creative and innovative, to recognize inhibitors to creativity and innovation, effective techniques to enhance creativity and innovation in coworkers, tools to produce creative and innovative solutions to technical, managerial, and process challenges.

ACE Accreditation

Design for Manufacturability and Assembly (APPEL-DMA)

2.1 IACET CEUs

AUDIENCE: This course is for the NASA technical workforce and program managers involved in the design, manufacture, and assembly of space program hardware who wish to become familiar with key technological information on manufacturing processes of strategic interest to NASA.

GOAL: This course was developed with the input of engineers and craftsmen throughout the agency to introduce participants to the skills and insight necessary to design mechanisms, devices, and structural components and produce them quickly, cost effectively, and of high quality. Participants will learn how to create products that function correctly and robustly, and about the importance of early involvement of key stakeholders.

LEARNING METHODS: This three-day introductory course is presented in a Design For X (DFX) format, where X can be manufacturability, assembly, serviceability, or other technological needs. The course includes a modular, expert-led lecture with visuals, videos of key manufacturing processes, in-class demonstrations, case studies, and group exercises. A NASA machine shop tour and machinist and designer panel discussions are also offered in conjunction with this course when possible.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe how the integrated design, manufacturing, and assembly process works.
- Explain the standard set of design rules and guidelines associated with the processes being considered.
- Apply a concurrent engineering design process that includes Design for Manufacture early in the product realization process, and team collaboration throughout.
- Recall sources for knowledge about the design for manufacture processes, then use them to best select between several competing processes.
- Discuss the science and physics of machining, and general manufacturability guidelines for different machining operations.
- Calculate a product's major cost, schedule, and quality drivers.
- Employ Geometric Dimensioning and Tolerancing (GDT) concepts and practices.
- Propose typical tolerances, surface finishes, and process times that are easily achievable, and those that are achievable only with significantly extra time, cost, and/or effort.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Integrated design, manufacturing, and assembly process; typical machining operations, tolerances, surface finishes, and process times; standard design rules and guidelines; cost, schedule, and quality drivers.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

Earth, Moon, and Mars (APPEL-EMM)

2.1 IACET CEUs

AUDIENCE: This course is for NASA engineers and scientists who are interested in understanding the geological systems and events that shape Earth, and then relating that knowledge to the moon, Mars, and other planetary bodies.

GOAL: Most engineering majors in academia are not required to take a course in geology. At NASA, engineers are tasked with exploring our own planet, the moon, and Earth's closest neighbor Mars. Participants will learn how planetary bodies are formed, the kinds of dynamic geologic processes that continue to operate on them today, and theories about their futures. Participants also discover unique geologic properties of the moon and Mars, and the challenges of exploring them with robots and humans.

LEARNING METHODS: This three-day survey course features lectures and interactive classroom discussions. Participants examine the current ideas about the structure, dynamics, and composition of the moon and Mars, using evidence from meteorites, satellite remote sensing, and previous NASA missions (manned and unmanned) to their surfaces. Real rock, mineral, and fossil samples are also used in the classroom to further explain the Earth's geological processes.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Debate hypotheses about the formation and history of Earth, moon, Mars, and other planetary bodies.
- Describe the dynamic systems that continue to shape our planet and how they impact life on Earth, such as energy sources, water availability, climate change, and natural hazards.
- Recognize the forces and influences (such as life) that continue to change Earth, moon, and Mars.
- Examine geological conditions that humans could face as they continue to explore the moon, Mars, and other planetary bodies.
- Describe how different planetary compositions may affect lunar and Martian vehicles and landing gears.
- Identify potential signatures of ancient life that might still remain on Mars.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Formation, history, and composition of the Earth, moon, Mars, and other planetary bodies; Earth's dynamic geological systems; forces and influences that continue to change Earth, moon, and Mars; lunar and Martian geology and their impact on design of exploration vehicles and landing gears; science of the solar system; searching for life.

Introduction to Aeronautics (APPEL-I-AERO)

2.4 IACET CEUs

AUDIENCE: This course is designed for anyone interested in a big-picture overview of aeronautics. No technical background is necessary.

GOAL: This four-day course is all about aircraft—how they fly, and why they look the way they do. Using design as a common thread, this course provides a solid understanding of the basics of aeronautical engineering, including low- and high-speed aerodynamics, stability and control, structures and materials, propulsion systems, and aircraft performance. Although the focus is clearly on conventional aircraft, discussion will include other air vehicles including airships, helicopters, stealth, hypersonic, unmanned, short takeoff and landing (STOL) vehicles, and micro-air vehicles. At the end of this course, participants will be able to identify and understand the design features of an aircraft and have an appreciation for the impact of modifying its design (for example, adding tip tanks).

LEARNING METHODS: Lectures, hands-on exercises, practical examples, and discussions are employed to support the lesson objectives. In addition, an off-site visit to a local aircraft museum, airport, or aero club reinforces the classroom discussions.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Explain why standard atmosphere is important in the field of aeronautics.
- Define lift and drag, explain how lift is generated, and identify the various components of drag.
- Explain why an aircraft "stalls" at a high angle of attack.
- Describe how flow properties change across a shock wave and an expansion wave.

- Describe design techniques used to minimize drag due to lift and wave drag.
- Explain the significance of (L/D)max and locate (L/D)max on a drag-versus-velocity graph.
- Identify high-lift devices and state their purpose.
- Name the aircraft axes, the motion of each, and the conventional control surface(s) that produce each motion as well as describe the pilot's input.
- Identify design and operational factors that contribute to achieving pitch stability.
- Describe the structural considerations and elements of a given aircraft.
- Explain how thrust is generated and demonstrate an understanding of the trade-offs associated with aircraft/engine integration.
- Identify and explain the impact of six factors (e.g., density altitude) on takeoff and landing performance.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Aeronautics, aircraft design fundamentals, stability and control, aircraft aerodynamics, aircraft performance, propulsion systems.

Introduction to Sustainable Facilities (APPEL-ISF)

2.3 IACET CEUs

AUDIENCE: This course is designed for those who plan, design, operate, maintain, renovate and/or manage existing and new facilities and surrounding environment.

GOAL: This course offers a fundamental understanding of NASAs approach to achieving sustainable facilities at NASA. Course modules include: a) NASAs sustainable facility requirements including the Five Guiding Principles; b) useful methods and building technologies for existing and new structures; c) site considerations; d) building commissioning and lessons learned from retro-commissioning; e) green building rating system overview; f) LEED (Leadership in Energy and Environmental Design) principles for NC New Construction and EB – Existing Buildings); g) integrated project delivery; and h) trends, such as ASHRAE Standard 189.1 and its relationship to LEED.

The goal is to enable participants to acquire or refine existing expertise that promotes sound and sustainable methods, technologies, and practices that help the Center and the agency lower operating and resource costs and achieve sustainability goals.

LEARNING METHODS: This course contains modules designed to be interactive, with presentations, discussions and several LEED checklist exercises, which should leave the host Center with useful information for its use.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe the methods and technologies used to design and operate sustainable facilities, including: effective resource management; water, energy and material conservation; and enhanced building envelope.
- Describe the differences between building commissioning, re-commissioning and retro-commissioning; know how to implement the development of a useful commissioning plan; and know the importance of integrating building automation and controls systems into a commissioning plan.
- Explain assessing and capitalizing as it relates to the remaining useful life of a facility and the basics of life-cycle cost analysis calculations.
- Identify the appropriate LEED rating system and certification process for a planned project.
- Explain NASAs and the Centers sustainability requirements, policy, goals, and activities.
- Describe their personal roles in fostering a sustainability culture within NASA, and support their center in achieving sustainability targets and goals.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: High performance sustainable design and implementation strategies for facilities, Cost-effective energy- and water-saving techniques for buildings, Internal and external policies, regulations, and requirements for sustainability, Life-cycle assessment requirements, considerations, and techniques, LEED principles for new construction and existing buildings.

Introduction to Green Engineering (APPEL-GREEN)

2.3 IACET CEUs

AUDIENCE: This course is designed as graduate-level seminar for engineers, scientists, project managers, and others who design products, processes, or systems and want to understand, quantify, and reduce the associated environmental impacts.

GOAL: This three-day course provides an introduction to the topic of green engineering, a tool for reducing the environmental impact of products, processes, and systems and making them more sustainable. From a NASA perspective, green engineering is an engineering best practice that considers environmental impacts as another design risk for mission success.

LEARNING METHODS: Learning will be accomplished primarily through lectures and examples, with class discussion and group exercises on key concepts. Basic concepts will be presented along with NASA examples where available and appropriate. The exercises and class discussions will complement the lectures to encourage participants to consider how various concepts and methods can be directly applied to current and future design projects as well as the NASA design process and culture. Resources will be provided so that participants can continue to learn and apply the course concepts to future projects.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Identify and communicate NASA engineering challenges with respect to environmental impacts as well as future risks, requirements, and potential solutions.
- Explain the different phases for a product, process, or system over the entire life cycle and give examples of potential environmental impacts and risks in each.
- Describe and apply basic life-cycle assessment (LCA) techniques for engineering projects.
- Develop an inventory of inputs/outputs for products/processes/systems.
- Develop a simple streamlined LCA template for use in their job function.
- Identify best practices and resources for continued learning and application of sustainability principles to NASA projects.
- Employ environmentally conscious designs, materials selection, and manufacturing techniques—enhanced through interdisciplinary teamwork.
- Design and develop materials, products, processes, hardware, and systems that are inherently safer, generate less waste, and use energy efficiently.
- Practice minimizing impacts associated with environmentally-driven risks, especially through an understanding of policies, regulations, and other external requirements (U.S. and international).
- Use available green engineering and sustainability tools and resources, along with NASA expertise, within system design and development efforts.
- Explain their role in fostering a sustainability culture within NASA.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Systems thinking, sustainability, green engineering, environmental impacts, environmental risk management, incorporating environmental issues into decision frameworks, life-cycle assessment (LCA), chemical toxicology, biomimicry.

NOTES: The first part of this course introduces and reviews various underlying concepts regarding sustainability, green engineering, environmental impacts, and chemical toxicology. The second part of this course focuses on specific tools for the reduction of environmental impacts including LCA. Examples from various engineering disciplines will be used including relevant NASA projects. This course is not focused on green buildings and facilities, though examples from building systems will be used where relevant.

Mission Success First: Lessons Learned

1.4 IACET CEUs

AUDIENCE: This course is for engineers, technical managers, and program/project managers engaged in the development or oversight of aerospace systems and components who wish to gain wisdom from NASA's lessons learned.

GOAL: This course enables participants to study more than 30 historical engineering incidents (taken from NASA's extensive internal reservoir of engineering case studies), examine the root causes of these mishaps, and derive applicable real-world lessons from them. They will also understand that rationalizing and accepting deviations from established norms is common yet unacceptable, and that implementing specific strategies and project principles are the best means of preventing failure in the demanding NASA environment. They will also understand the importance of communicating lessons learned, where to find NASA lessons learned database, how and when to use them, and how to best capture and share their own successes and failures as official lessons learned.

LEARNING METHODS: This two-day course is facilitated by former NASA engineering managers with space system development experience and firsthand knowledge about dozens of the engineering mishaps and near-misses examined in the course. Rare archival photographs and videos are included in the multimedia presentation, along with informative personal anecdotes. Participants will review and critique these incidents, perform critical analysis of actual events, and learn to use this knowledge within their own current projects.

SPECIFIC OBJECTIVES: Upon completion of this course, participants should be able to:

- Identify system-specific lessons from selected historical cases.
- Describe the root causes of well known case histories, such as the Apollo 13 oxygen tank and the space shuttle Challenger "normalization of deviance" concept, as well as lesser-known examples from NASA archives.
- Demonstrate how normalization of deviance can affect decision points, and how to avoid it.
- Translate extracted lessons into concrete strategies for eliminating root causes of problems and use these in daily work.
- Support the importance of communicating lessons learned, including mining the NASA lessons learned database as appropriate and capturing and sharing their own successes and failures as official lessons learned.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Assessment of historical aerospace mishaps to learn system-specific lessons and root causes; analysis of "normalization of deviance" concept; critical thinking, engineering design and analysis processes, technical decision making, and project principles; non-analytical aspects of design; application of concrete strategies to eliminate root causes of problems.

NASA Missions: Engineering Exploration (APPEL-MSN)

2.3 IACET CEUs

AUDIENCE: This course is for NASA engineers and technicians who perform "engineering in the service of exploration" and want to gain a better understanding of human spaceflight and robotic missions—past, present, and future—that resulted, or will result, from technological pushes, geopolitical factors, and personal passion.

GOAL: This course enables participants to recognize how the driving forces behind agency wide successes are more than science and analytics, and how innovation, teamwork, persistence, and passion are key components of an engineer's daily work. Through discussions of NASA's past accomplishments, current undertakings, and potential future endeavors—as seen from engineering, scientific, historical, and human perspectives—participants learn to apply these insights in their own daily thinking. They will also comprehend the rationale for and importance of the endeavors that support the agency's current vision, and be able to personally craft and publicly convey the purpose and significance of the nation's space program in their own words.

LEARNING METHODS: This three-day course offers an expert-led, multi-media rich presentation detailing 50+ years of NASA's key historical, current, and future programs. It is augmented by highly interactive discussions, along with behind-the-scenes personal stories and thoughts from the instructor and participants themselves.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Discuss the history, engineering successes, and biographical anecdotes of major NASA human spaceflight missions (including Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, Space Shuttle, Shuttle-Mir, and International Space Station).
- Explain the purpose and accomplishments of major NASA robotic missions, (including early near-Earth, Earth-observation, lunar, inner and outer solar system, and space-based astronomy missions).
- Examine future NASA missions, technical challenges, and associated timelines for human spaceflight programs (ISS, Constellation, commercial partnerships); robotic missions (James Webb Telescope, Terrestrial Planet Finder, Mars Science Laboratory, Mars Sample Return, Europa ocean exploration) and the challenges involved with sending humans to the moon, Mars, and asteroids.
- Defend—internally and in public forums—the rationale and importance of the NASA space program, including its significant role in technology research and development, education, exploration, national security, the US economy, and humankind's long-term survivability.
- Formulate the "annual cost of NASA" in terms that the public can relate to, and then communicate the message.
- Employ a myriad of recommended resources for learning more about NASA's history, present missions, and future endeavors.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: History, engineering successes, and personal points-of-view of major NASA human spaceflight missions; purpose and accomplishments of major NASA robotic missions; technical challenges and proposed timelines of future NASA programs and missions; internal and public communications of the importance of NASA, its national and global roles, and its cost.

Planetary Protection: Policies and Practices (APPEL-PP)

AUDIENCE: NASA has developed this course on planetary protection policies and practices to familiarize current and future practitioners with NASA and COSPAR planetary protection programs. The course provides a comprehensive review of all applicable policies, practices, and procedures necessary to implement planetary protection requirements successfully, emphasizing integration of managerial, administrative, and laboratory aspects of planetary protection.

GOAL: This three-day course focuses on the theory and application of planetary protection principles. Participants learn how the work of personnel with diverse skills and responsibilities is coordinated to develop an effective program of implementing planetary protection requirements for planetary missions.

LEARNING METHODS: Learning is accomplished through a combination of lecture and structured hands-on laboratory training. The lecture portion of

the course presents NASA requirements and implementation guidance, including industry examples. The laboratory portion of the course complements the lecture by demonstrating key principles of microbiology and laboratory assay requirements.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Describe the scope and requirements of planetary protection.
- Interpret and distinguish implementation requirements and strategies for planetary missions.
- Identify and plan the microbiological aspects of planetary protection including assay and bioburden accounting requirements.

NOTES: Please see http://planetaryprotection.nasa.gov/course for registration instructions.

ACE Accreditation

Seven Axioms of Good Engineering (APPEL-SAGE)

PMI® Course ID: SAGE33 I 20 PDUs I 2.0 IACET CEUs

AUDIENCE: This course is for NASA engineers and project managers who are interested in understanding the role of historical case studies and engineering failures in critical thinking and good engineering design processes, and learning how to avoid classic design errors.

GOAL: This course takes a reflective look at numerous case studies, from within NASA and the outside world, to discover where the root causes of most failures reside. After a brief introduction to design, participants investigate various failure examples, then lead themselves to the discovery and on-the-job application of axioms that bring a non-technical, yet crucial, sense of wisdom to the engineering design and project management decision-making processes.

LEARNING METHODS: This three-day course presents seven key concepts for axiomatic design, including: (1) avoiding a selective use of historical design data; (2) extrapolating existing data into unknown regions of the design space only with extreme caution; (3) understanding the design's sensitivity and robustness; (4) always testing against physicality; (5) guarding against unanticipated loads and/or failure modes; (6) avoiding highly coupled system unless a strong benefit is shown; and (7) ensuring human understanding of how the system works. Participants discuss historical case studies on failure, including: GE refrigerator rotary compressor failure; space shuttle Columbia accident; Apollo liquid oxygen (LOx) tank; Pioneer 10 spacecraft; recurring mistakes in suspension bridge design; Hubble Space Telescope primary mirror; U.S. Navy's Mark 14 magnetic exploder malfunction; Kansas City Hyatt Regency walkway collapse; Ocean Ranger sinking; and the Three-Mile Island partial meltdown. Participants also are expected to create design corollaries and a case study based on their own personal experiences, and then present their engineering design cases to the class, highlighting pertinent engineering axioms.

SPECIFIC OBJECTIVES: Upon completion of this course, participants will be able to:

- Recognize the value of case studies in critical thinking through the extraction of key decision-making aspects associated with engineering processes.
- Define and explain the seven design engineering axioms, and recognize ways that classic errors occur and ways to avoid them.
- Employ non-analytical insight as part of the design process.
- Transform design data into design knowledge.
- Practice researching and incorporating lessons learned into everyday design processes.
- Evaluate one's own successful and failed design projects to create case studies that highlight and share good and bad engineering practices.

COMPETENCIES AND TECHNICAL AREAS ADDRESSED: Seven key engineering design principles and classic design errors; critical thinking, technical decision making, and engineering best practices; non-analytical aspects of design; practice of researching case studies and lessons learned in everyday design processes.

NOTES: The American Council on Education (ACE) has recommended that 1 transferrable graduate-level credit be awarded for the successful completion of this course.

CHIEF KNOWLEDGE OFFICER

Chief Knowledge Officer

Who We Are

The NASA Chief Knowledge Officer (CKO) is responsible for policy and integration of knowledge services across programs and projects in the centers and mission directorates. The NASA CKO reports to the NASA Chief Engineer. NASA's new knowledge policy has established a federated model for coordinating agency knowledge activities, with each organization determining the approach that best meets its needs while recognizing that knowledge applicable to all mission directorates and centers will be shared to the fullest extent possible.

The NASA CKO coordinates a community of knowledge professionals who serve as chief knowledge officers or primary knowledge points of contact for their respective centers, mission directorates, and cross-agency organizations. Specifically these include:

NASA Knowledge Community		
NASA Centers	**Mission Directorates**	**Cross-Agency Organizations**
Ames Research Center	Aeronautics Research	Academy for Program/Project and Engineering Leadership (APPEL)
Dryden Flight Research Center	Human Exploration Operations	NASA Engineering Safety Center (NESC)
Glenn Research Center	Science	NASA Engineering Network (NEN)
Goddard Space Flight Center	Space Technology	NASA Safety Center (NSC)
Jet Propulsion Laboratory		Office of Human Capital Management (OCHM)
Johnson Space Center		Office of Procurement (OP)
Kennedy Space Center		NASA Scientific and Technical Information (STI)
Langley Research Center		
Marshall Space Flight Center		
Stennis Space Center		

What We Do

The NASA CKO is responsible for policy and integration of knowledge services across programs and projects at the centers, mission directorates, and cross-agency organizations. The CKO serves as the advocate for the agency's knowledge needs, facilitating increased awareness of formal and informal work happening across NASA and serving as a conduit between practitioners and agency leaders to ensure the workforce has the tools and resources necessary to meet its most pressing knowledge challenges.

Knowledge Tools

The CKO facilitates the dissemination of knowledge resources that cultivate, identify, retain, and share knowledge in order to continuously improve NASA's ability to execute its mission. These knowledge tools include the NASA knowledge community's website km.nasa.gov, the NASA Knowledge Map, and the NASA Knowledge Sharing Toolkit.

NASA Knowledge Community Web Site

NASA's knowledge community consists of the chief knowledge officers and primary knowledge points of contact at each NASA center and mission directorate, and at participating cross-agency organizations. The NASA CKO has created a web portal for this community to disseminate knowledge sharing best practices among their NASA colleagues and beyond: http://km.nasa.gov.

NASA Knowledge Map

NASA's practitioners and organizations engage in a wide range of knowledge activities, from self-directed queries to social interactions that bring people together to share stories. The NASA Knowledge Map represents existing knowledge services across the agency.

You can access the NASA Knowledge Map at http://km.nasa.gov/knowledge-map.

NASA Knowledge Sharing Toolkit

In coordination with the NASA Knowledge Map, the NASA Knowledge Toolkit is an evolving collection of knowledge sharing strategies and techniques that NASA practitioners can use to acquire, capture and transfer critical knowledge.

Knowledge Sharing Events

In addition to facilitating greater collaboration and coordination among NASA's knowledge community, the CKO promotes best practices in knowledge sharing through tools, publications, and activities. This has proven to be an effective strategy for helping to build an agency-wide community of reflective practitioners who understand the necessity of continuous learning and sharing.

Case Study Series

AUDIENCE: The Case Study Series bring together NASA practitioners and leaders for a facilitated discussion on a particular topic.

GOAL: These discussions are designed to disseminate the experience and wisdom embedded in the stories of NASA missions to managers and project team members. Case Study Series events transfer specific knowledge to and among participants by placing participants a position to think through

choices faced by decision-makers in real-life situations.

LEARNING METHODS: Mission stories are shared and explored through a review of a written case, a facilitated discussion of the events described in the case, and just-in-time presentation of human factors and organizational dynamic principles.

LEARNING OBJECTIVES: Case Study Series discussions enable participants to:

- Make critical decisions based on contextual analysis.
- Understand complex social-cognitive environments in which time-sensitive technical decisions must be made.
- Recognize the relationship between the execution of simple practices and mission/project outcomes.

Engaging Leaders in Knowledge (ELK) Forum

AUDIENCE: ELK Forums bring knowledge experts from industry, international partners, and academia to interact with NASA practitioners and leaders.

GOAL: These forums bring knowledge experts from industry and academia to interact with NASA practitioners in order to highlight state-of-the-field insights and best practices, and explore how those insights and practices are applicable to NASA.

LEARNING METHODS: Keynote presentation by a knowledge expert followed by a panel of leaders from NASA, industry, and academia. These events are simulcast live to other NASA centers and recorded for web-based distribution.

LEARNING OBJECTIVES: ELK Forums enable participants to:

- Explore and discuss best practices regarding knowledge acquisition, capture, and transfer.
- Learn how those best practices can be/are applied at NASA.
- Connect with NASA peers and leaders.
- Cultivate a strong and innovative knowledge community.

Knowledge Forum

AUDIENCE: Knowledge Forums bring together knowledge experts from NASA, industry, and academia to explore issues such as knowledge networks, knowledge capture and preservation, and the challenges of managing and transferring knowledge in a project-based organization.

GOAL: These forums examine challenges, lessons learned, and best practices in acquiring, capturing, and transferring institutional knowledge in complex organizations.

LEARNING METHODS: Brief presentations and discussions focus on real-world examples. Interactive group activities reinforce key themes and provide sharing and networking opportunities for participants.

LEARNING OBJECTIVES: The Knowledge Forums enable participants to:

- Explore and discuss different aspects of knowledge acquisition, capture, and transfer.
- Share best practices and lessons learned in addressing critical organizational challenges to use knowledge effectively.

- Cultivate a strong and innovative knowledge community.

Masters Forum

AUDIENCE: Masters Forums bring together outstanding project managers and engineers from NASA, private industry, and other government agencies.

GOAL: Through presentations and group discussions, Masters Forums support effective sharing and networking among expert practitioners as well as leaders from other federal government agencies, international space agency partners, universities, and private industry. These events promote organizational learning at NASA by cultivating a community of reflective practitioners and developing the leadership expertise of the agency's experienced and emerging project managers.

LEARNING METHODS: This presentation-based format provides extensive review of specific project topics in order to facilitate discussion, and offers participants the opportunity to interact with presenters and colleagues in order to compare and contrast differing methods of applying project management tools and techniques.

LEARNING OBJECTIVES: The Masters Forum enables participants to:

- Share project management best practices and lessons learned.
- Expand their knowledge and understanding of programs and projects at different centers.
- Build cross-center relationships.
- Extend their professional networks of expert practitioners.
- Learn by sharing their own stories with colleagues.

Masters with Masters

AUDIENCE: Masters with Masters events provide opportunities for NASA civil servants and other engineering and project management professionals to interact with expert practitioners.

GOAL: The Academy developed Masters with Masters as part of its ongoing efforts to create a cohesive community of project management and engineering practitioners across NASA .

LEARNING METHODS: Stories and lessons learned are shared from two expert practitioners as they reflect on both their past experiences and upcoming challenges. Many sessions are simulcast on NASA TV and via social media, allowing attendees to engage with featured guests in real time.

LEARNING OBJECTIVES

- Masters with Masters enables participants to:
- Capture and share the best practices, common experiences, and lessons learned by project management and engineering professionals.
- Cultivate a cohesive community of project management and engineering practitioners across NASA

Principal Investigator (PI) Team Masters Forum

AUDIENCE: Principal Investigator (PI) Team Masters Forums

bring together principal investigators, project managers, and project scientists of potential NASA Science Mission Directorate (SMD) missions to share knowledge and lessons learned in order to maximize mission success. PI Forums are held following the selection of candidate PIs as a part of SMD's science mission announcement of opportunity selection process. Attendance of key members of PI teams is required, per NASA SMD Policy Directive SPDF-13b.

AUDIENCE: Principal investigators, project managers, and project scientists of potential NASA SMD missions.

GOAL: This forum develops the leadership expertise of the agency's principal investigator teams by helping PI-led mission teams understand the role of a principal investigator at NASA, which facilitates personal and team growth and development.

LEARNING METHODS: Stories, shared experiences, and lessons learned from a broad range of science missions enable NASA's PI-led mission teams to engage and share with fellow practitioners.

LEARNING OBJECTIVES: These events enable participants to:

- Share project management, system engineering, and science mission best practices and lessons learned.
- Cultivate a community of reflective practitioners within teams.
- Solidify cross-organizational relationships in support of agency projects.
- Build understanding of and expertise in principles, factors, and capabilities that enable PI-led teams to achieve mission success.
- Increase ability to execute missions in a way that meets the science objectives within budget and schedule constraints.

Publications, Multimedia, and Social Networking: Connect and Learn

Digital Storytelling and Communications

Communication is central to all leadership and management challenges. The complexity of NASA's programs and projects demands an open, vigorous culture in which communication is continuous, empowering individuals at all levels to ask questions, share information, and raise concerns. The Academy of Program/Project and Engineering Leadership (APPEL) is committed to promoting open communication through a number of channels available through the APPEL website at appel.nasa.gov.

ASK Magazine

http://go.nasa.gov/1bXqEyA

ASK Magazine helps NASA managers and project teams accomplish today's missions and meet tomorrow's challenges through quarterly insights and stories recounting real-life experiences that communicate important practical wisdom and best practices. Reaching more than 88,000 online subscribers, ***ASK*** allows NASA managers, scientists, and engineers as well as industry, academic, and international partners to share valuable experience-based knowledge and foster a reflective community. In keeping with the Academy's mission of promoting excellence in project management and engineering, ***ASK*** includes articles about meeting the technical and managerial demands of complex projects, as well as insights into organizational knowledge, learning, collaboration, performance measurement and evaluation, and scheduling. You can help ***ASK*** provide the stories you need and want by contacting our editors through the APPEL website.

E-Books

http://go.nasa.gov/16nryyS

APPEL uses digital media such as e-books to share critical knowledge and learning resources. Two recent publications include NASA's Journey to Project Management Excellence, a detailed account of APPEL's approach for addressing the learning needs of NASA's project and engineering workforce, and the Orbital Debris Management and Risk Mitigation iBook, APPEL's first-ever interactive iBook, which supplements an existing APPEL course on orbital debris.

ASK News

http://go.nasa.gov/1bXqrLl

While APPEL's long-standing flagship publication ***ASK Magazine*** remains a quarterly forum for the NASA workforce to share personal stories, knowledge, and lessons learned, ***ASK News*** provides brief, frequent, news-you-can-use updates. Derived from the monthly newsletter ***ASK the Academy, ASK News*** enables APPEL to share news as it happens, providing NASA practitioners with timely information about the Academy's activities (e.g., new courses and training opportunities), federal news (e.g., reports from Office of Management and Budget, Government Accountability Office, and Inspector General), stakeholder news and research (e.g., international, industry, and academic partners), stories from the young professional community, and other features that promote professional development and knowledge sharing across NASA's technical workforce.

Case Studies

http://go.nasa.gov/1bXoVJH

Case studies illustrate the kinds of decisions and dilemmas managers face every day, and as such provide an effective learning tool for project management. Due to the dynamic and complex environment of projects, a great deal of project management knowledge is tacit and hard to formalize. A case study captures the complex nature of a project and identifies key decision points, allowing the reader an inside look at the project from a practitioner's point of view. APPEL's case studies cover a variety of topics, ranging from the STS-119 launch decision to the lean approach to project management practiced by the LCROSS team.

iTunes University

http://go.nasa.gov/1c6WCtb

APPEL hosts videos and podcasts from thought leaders, master practitioners, and innovative thinkers through its iTunes U library, featuring a variety of topics including green engineering, policy and politics, systems engineering, leadership development, and international collaboration. Most notably, the site hosted the first APPEL iBook and iTunes U course, which tackled the topic of orbital debris. Other new content included downloadable versions of ASK Magazine in both PDF and EPUB formats, a video case study of the first Project HOPE team, and lectures from course instructors.

YouTube

http://go.nasa.gov/1bXpZNt

The APPEL YouTube Channel hosts over 250 videos that vary in length and content. Videos from Masters with Masters, Principal Investigator Forums, APPEL course modules, special speakers, and video case studies are often organized into specific playlists or tagged with specific keywords. This platform nearly doubled the total number of views from the previous year, with its strongest following among users ages 45-64.

Twitter

http://go.nasa.gov/1bXpcfD

With over 10,000 followers, @NASA_APPEL provides timely updates and stories to the community and live-tweets special events, including Masters with Masters, NASA's Project Management Challenge, and other special learning events across the agency and the federal government. APPEL also engages in discussion, responds to feedback, and answers questions from the community about stories, videos, courses, and other knowledge resources through this platform.

Facebook

http://go.nasa.gov/1bXpAKZ

Facebook allows for longer messages, asynchronous conversations, and an ongoing timeline that is easy to browse. Through this platform, the APPEL has a strong following among students and young professionals around the world. APPEL encourages its visitors to share, like, or comment on interesting images and short announcements that link back to the larger story on appel.nasa.gov.

Flickr

http://go.nasa.gov/1bXpMdf

The APPEL Flickr photostream tells project and training stories through images, often presenting different or lesser-known angles, such as the relationship between Project Lunar Orbit and Landing Approach (LOLA) the Lunar-Orbit Rendezvous decision and planning. A new series includes capturing ASK Magazine stories in 20 pictures or less, highlighting powerful images with key snippets from each story. Specific photo sets are used to illustrate written stories, create galleries used for courses, and capture the progression of training and knowledge sharing events. This platform enhances APPEL's ability to integrate visual content with written content as it is easily embedded into pages on appel.nasa.gov.

DEVELOPING COMPETENCIES FOR SUCCESS

Developing Competencies for Success

Project Management and Systems Engineering Competency Framework

The Academy's developmental framework is based on a rigorous set of competencies that practitioners should have in order to perform their jobs. These competencies were derived from many sources, including extensive interviews with several hundred highly successful project managers and systems engineers at NASA. The resulting competencies were vetted with both internal and external organizations to ensure completeness and accuracy. Since the competencies form the foundation of the development program, they are under configuration control and are reviewed and updated as appropriate. The latest update was done in June 2009.

A key step for NASA's technical practitioners is to understand the competencies associated with their roles. The Academy helps practitioners develop proficiency in their competencies in order to reach the highest level of performance. The diagram below illustrates the required competencies for both project management and systems engineering professionals at NASA. As shown below, the framework consists of five project management competency areas, three systems engineering competency areas, and five competency areas common to both disciplines.

The competency areas describe, in broad terms, the expectations of project management and systems engineering personnel in terms of particular components or functions of the job. There are underlying competencies within each major competency area that provide examples of the knowledge, skills, and behaviors that project managers and systems engineers are expected to possess and/or perform at different career levels. Performance-level descriptions for each competency can be found on the Academy's web site at http://www.nasa.gov/offices/oce/appel/pm-development/pm_se_competencies.html.

To further support individuals as they work to identify their appropriate development activities, the Academy provides a course competency matrix (see next page). This tool can be used as a guide in the selection of courses based on competency development and individual learning needs. In addition to competencies, the matrix includes other course elements that may be of interest to individuals considering a particular course. The table represents a snapshot of all courses and includes information such as course duration, audience, and course goals.

Project Management Competencies

- PM 1.0 Project Conceptualization
- PM 1.1 Project Proposal
- PM 1.2 Requirements Development and Management
- PM 1.3 Acquisition Management
- PM 1.4 Project Planning
- PM 1.5 Cost-Estimating
- PM 1.6 Risk Management
- PM 1.7 Earned Value Management
- PM 2.0 Resource Management
- PM 2.1 Budget and Full Cost Management
- PM 2.2 Capital Management
- PM 3.0 Project Implementation
- PM 3.1 Systems Engineering
- PM 3.2 Contract Management
- PM 4.0 Project Closeout
- PM 4.1 Stakeholder Management
- PM 4.2 Technology Transfer and Commercialization
- PM 5.0 Program Control and Evaluation
- PM 5.1 Tracking/Trending of Project Performance
- PM 5.2 Project Control
- PM 5.3 Project Review and Evaluation

Common Competencies

- C 1.0 NASA Internal and External Environments
- C 1.1 Agency Structure, Mission, and Internal Goals
- C 1.2 NASA Procedures And Guidelines
- C 1.3 External Relationships
- C 2.0 Human Capital Management
- C 2.1 Staffing and Performance
- C 2.2 Team Dynamics and Management
- C 3.0 Security, Safety, and Mission Assurance
- C 3.1 Security
- C 3.2 Workplace Safety
- C 3.3 Safety and Mission Assurance
- C 4.0 Professional and Leadership Development
- C 4.1 Mentoring and Coaching
- C 4.2 Communication
- C 4.3 Leadership
- C 4.4 Ethics
- C 5.0 Knowledge Management
- C 5.1 Knowledge Capture and Transfer
- C 5.2 Knowledge Sharing

Systems Engineering Competencies

- SE 1.0 System Design
- SE 1.1 Stakeholder Expectation Definition
- SE 1.2 Technical Requirements Definition
- SE 1.3 Logical Decomposition
- SE 1.4 Design Solution Definition
- SE 2.0 Product Realization
- SE 2.1 Product Implementation
- SE 2.2 Product Integration
- SE 2.3 Product Verification
- SE 2.4 Product Validation
- SE 2.5 Product Transition
- SE 3.0 Technical Management
- SE 3.1 Technical Planning
- SE 3.2 Requirements Management
- SE 3.3 Interface Management
- SE 3.4 Technical Risk Management
- SE 3.5 Configuration Management
- SE 3.6 Technical Data Management
- SE 3.7 Technical Assessment
- SE 3.8 Technical Decision Analysis

STRATEGIC PARTNERS AND EXTERNAL STAKEHOLDERS

Strategic Partners and External Stakeholders

AMERICAN COUNCIL ON EDUCATION (ACE)

The American Council on Education's College Credit Recommendation Service (ACE CREDIT) has evaluated and recommended college credit for 11 of the Academy's courses. ACE, the major coordinating body for all the nation's higher education institutions, seeks to provide leadership and a unifying voice on key higher education issues and to influence public policy through advocacy, research, and program initiatives.

ACE CREDIT connects workplace learning with colleges and universities by helping adults gain access to academic credit at colleges and universities for formal courses and examinations taken in the workplace or other settings outside traditional higher education. For more than 30 years, colleges and universities have trusted ACE CREDIT to provide reliable course equivalency information to facilitate their decisions to award academic credit.

For more information, visit the ACE CREDIT web site www.acenet.edu/credit.

INTERNATIONAL ASSOCIATION FOR CONTINUING EDUCATION AND TRAINING (IACET)

The Academy has been approved as an authorized provider by the International Association for Continuing Education and Training (IACET), 1760 Old Meadow Road, Suite 500, McLean, VA 22102; 703-506-3275. In obtaining this approval, the Academy has demonstrated that it complies with the ANSI/IACET 1-2013 Standard, which is recognized internationally as a standard of good practice. As a result of the Academy's authorized provider membership status, it can offer IACET CEUs for its programs that qualify under the ANSI/IACET 1-2013 Standard.

NASA ENGINEERING NETWORK (NEN)

The NASA Engineering Network (http://nen.nasa.gov) is an integrated suite of tools that promotes collaboration, learning, and knowledge sharing among NASA's engineers. It connects engineers to other engineers as well as NASA resources through the following:

- NASA's Lessons Learned Information System (LLIS), which

provides official, vetted lessons learned from NASA programs and projects. Each lesson includes the summary of the precipitating event and recommendations that drive NASA's engineering training, best practices, policies, and procedures.

- NEN's Engineering Search is an enterprise search engine that mines the knowledge from NASA Lessons Learned and a continually growing number of repositories of interest.
- NEN's Communities of Practice (CoP) are facilitated communities where engineers may interact with their discipline's Technical Fellow, subject-matter experts, and other practitioners to leverage the knowledge, processes, and best practices created and employed by other engineers.

NEN works with the Academy to provide communities of practice for training courses so practitioners can find resources and continue learning after a course is complete. These communities include discussion boards, calendars of upcoming courses, and online resources.

NASA AGENCY TRAINING AND DEVELOPMENT OFFICE

The NASA Agency Training and Development Office extend opportunities to help employees gain the necessary knowledge and skill to fulfill NASA's mission through formal education, training, and on-the-job developmental experiences. The may be university coursework, traditional classroom, online learning, satellite broadcast, blended models, or on-the-job training.

The NASA Agency Training and Development Office is responsible for the agency's overall leadership development training needs serving all NASA centers, mission directorates, and mission support organizations. They work in collaboration with the center training offices, Headquarters' functional offices, and stakeholders in the SATERN online learning environment to ensure that employees receive opportunities to build their professional development in three main areas: building leaders, building technical excellence, and building effective organizations. The effort in these areas is focused on results by fostering a culture of honesty, learning, and knowledge sharing.

Specific agency training and development opportunities include short-term residential leadership and business courses, supervisory training, long-term leadership development programs for the GS 11-15 population, professional coaching and mentoring, and agency fellowship programs. All agency training and development offerings are based on the NASA Leadership Model, which can be found at http://www.leadership.nasa.gov.

NASA ENGINEERING and SAFETY CENTER (NESC)

NASA Engineering and Safety Center's (NESC) mission is to perform value-added independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success. The NESC engages proactively to help NASA avoid future problems.

At the core of the NESC is an established knowledge base of technical specialists pulled from the ten NASA Centers and from a group of partner and organizations external to the Agency. This ready group of engineering experts is organized into 15 disciplines areas called Technical Discipline Teams (TDT),

formally known as Super Problem Resolution Teams (SPRT). TDT members are from other NASA organizations, industry, academia, and other government agencies. By drawing on the mind of leading engineers across the country, the NESC consistently optimizes its processes, deepens its knowledge base, strengthens its technical capabilities, and broadens its perspectives, thereby further executing its commitment to engineering excellence. For more information: http://www.nasa.gov/offices/nesc/home/index.html.

OFFICE OF MANAGEMENT AND BUDGET (OMB) AND FEDERAL ACQUISITION INSTITUTE (FAI)

OMB Requirements for Program/Project Management Certification

In 2007, the White House OMB announced a new set of requirements for project management certification that applies to all civilian agencies, emphasizing the importance of well-trained and experienced project managers to the acquisition process and the successful accomplishment of mission goals. The Federal Acquisition Certification for Program/Project Managers (FAC-P/PM) establishes the necessary competencies, training, and experience requirements for eligible program and project managers in civilian agencies to become certified. FAI is the oversight organization for this requirement. Visit http://www.fai.gov for more information.

To meet OMB's requirements, NASA is required to certify existing and future experienced P/PMs who manage high-visibility projects defined as major acquisitions per NPR 7120.5. Center senior management, with guidance from the Program Management Council, is responsible for determining which positions fall under this threshold. At this time, it is not mandatory for P/PMs assigned to non-major projects or programs to be certified.

Continuous Learning Requirements for Certified P/PMs

Certified NASA P/PMs must complete 80 continuous learning points (noted as CPEs in SATERN) every two years to maintain certification. All Academy courses and activities are eligible for credit toward recertification. The list of Academy courses and their associated CPEs as well as other self-recordable items can be found in the SATERN Recertification Catalog. To view a list of P/PM recertification-applicable courses and activities in SATERN, please log in to a SATERN learner account and click the "Catalog" tab.

Please check the SATERN Recertification Catalog frequently for updates as center, discipline, and other agency-approved courses and activities will be added on an ongoing basis. Contact your Center Training Office for additional details or visit the Academy web site.

PROJECT MANAGEMENT INSTITUTE

PMI® Registered Education Provider—renewed May 2013

PMI is the leading membership association for the project management profession and is recognized around the world for the programs they conduct with governments, organizations, and industries as they recognize and embrace project management.

The Academy is a Registered Education Provider (REP) approved by PMI to issue Professional Development Units (PDUs) for its training courses and knowledge-sharing events.

Courses offered by PMI® REPs are preapproved for contact hours in fulfillment of certification eligibility requirements, as well as PDUs to fulfill the Project Management Professional (PMP)® Continuing Certification Requirements. The REP program has been designed to enhance the ongoing professional development of PMI®'s members, those credentialed through PMI, and others in the project management profession. The Academy currently offers more than thirty courses with PDU credits. The numbers of PDUs are shown on each course description. (A list of Academy courses and the relevant PDUs can also be found on the Academy web site: http://appel.nasa.gov.)

PMI®'s Certification Programs

Project management practitioners can advance their careers through PMI®'s globally recognized certification program that consists of a comprehensive certification program for professionals with varying levels of experience. The credentials are as follows:

- Certified Associate in Project Management (CAPM)®
- Project Management Professional (PMP)®
- Program Management Professional (PgMP)®

The Certified Associate in Project Management (CAPM)® Credential is for project team members who:

- Provide subject-matter expertise (e.g., marketing, finance, customer care, processing, and fulfillment).
- Serve as project team sponsors, facilitators, liaisons, or coordinators.

The Project Management Professional (PMP)® Credential is for candidates who:

- Perform their duties under general supervision and are responsible for all aspects of the project for the life of the project.
- Lead and direct cross-functional teams to deliver projects within the constraints of schedule, budget, and resources.
- Demonstrate sufficient knowledge and experience to appropriately apply a methodology to projects that have reasonably well-defined project requirements and deliverables.

The Program Management Professional (PgMP)® Credential is for candidates who:

- Under minimal supervision, are responsible and accountable for the coordinated management of multiple related projects directed toward strategic business and other organizational objectives. These programs contain complex activities that may span functions, organizations, geographic regions, and cultures. Program managers build credibility; establish rapport, and maintain communication with stakeholders at multiple levels, including those external to the organization.
- Define and initiate projects and assign project managers to manage cost, schedule, and performance of component projects, while working to ensure the ultimate success and acceptance of the program. Program managers maintain continuous alignment of program scope with strategic business objectives and make recommendations to modify the program to enhance effectiveness toward the business result or strategic intent. Program managers are responsible for determining and coordinating the sharing of resources among their constituent projects to the overall benefit of the program.
- Possess the knowledge and skills needed to be effective in both the project and business or government environment and to make decisions that accomplish strategic objectives. In addition, the program manager should have advanced skills in finance, cross-cultural awareness, leadership, communication, influence, negotiation, and conflict resolution.

For more information on the certifications, visit PMI®'s web site at http://www.pmi.org/Certification/which-PMI-Certification-is-Right-for-You.aspx.

What Credential Am I Eligible For?

The Academy provides a systematic approach to professional growth for program and project managers ranging from early on in their careers to more advanced levels. The figure on the facing page aligns the Academy's four-level development framework for project managers with PMI®'s current certification levels. By reviewing these requirements, individuals can determine the preparation process and relevant level of certification based on career level.

NASA PROJECT MANAGEMENT DEVELOPMENT FRAMEWORK AND PMI® CERTIFICATION ALIGNMENT

Project Management Development Framework	PMI® Certifications
Level 1: Project Team Members NASA employees who are at the beginning of their project management careers	Certified Associate in Project Management (CAPM)®: Must meet the following education and experience requirements and then pass exam: • Must have a secondary diploma (high school or global equivalent), 1,500 hours of work on a project team or 23 hours of formal education
Level 2: Managers of Small Projects NASA project practitioners who have established a solid base of technical expertise and who independently manage definite portions of projects	
Level 3: Managers of Large Projects NASA project practitioners who have had prior experience in projects at a supervisory level and manage larger projects	Project Management Professional (PMP)®: Must meet the following education and experience requirements and pass exam: • With a bachelor's degree (or global equivalent), 4,500 hours in a position of leading and directing projects, at least 36 months of PM experience and 35 hours of PM education, or • A secondary diploma (high school or global equivalent), 7,500 hours in a position of leading and directing projects, at least 60 months of PM experience and 35 hours of PM education
Level 4: Program Managers Upper-level managers serving as leaders of entire projects and programs of the organization as a whole	Program Management Professional (PgMP)®: A four year degree (bachelor's or the global equivalent), with at least 48 months of project management experience and 48 months of program management experience OR a secondary diploma (high school or the global equivalent), with at least 48 months of project management experience and 84 months of program management experience.

PMI® Professional Development Units (PDU) for Academy Courses

In order to satisfy Continuing Certification Requirements (CCR) and maintain an active credential status, individuals who have attained the PMP® and/or PgMP® credential(s) must accrue and report a minimum of 60 PDUs during each three-year CCR cycle. The PDU is the measuring unit used to quantify approved learning and professional service activities. Those certified are responsible for reporting qualifying activities as they occur. PDUs should be reported using the Online PDU Resources system accessible from a section of the PMI® web site: http://www.pmi.org/Certification/ Maintain-Your-Credential.aspx.

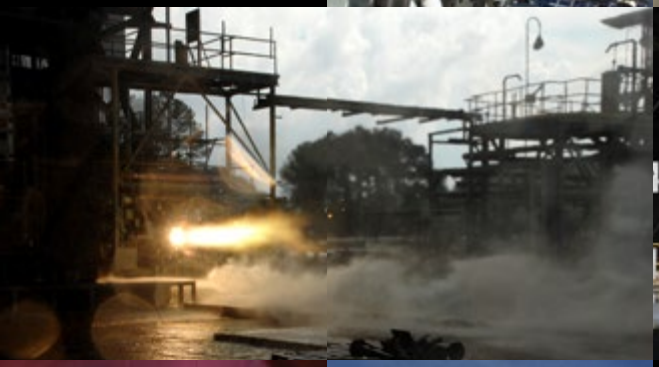
Below is a list of PMI®-registered APPEL courses, the PMI® Course ID, the number of assigned PDUs and course duration. Upon claiming your PDUs, you will need to have the Provider ID number, which is 1895.

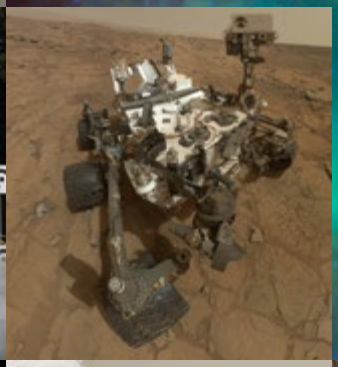
APPEL Course ID	Course Title	PMI® Course ID	PDU	Duration (Days)
AEVM	APPEL - Advanced Earned Value Management	APPEL-AEVM	14	2
AoA	APPEL - Pre-Acquisition Analysis, Including Analyses of Alternatives	AoA01	14	2
APM&ASE	APPEL - Advanced Project Management and Advanced Systems Engineering	APMSE03	26	4
APP	APPEL - Assessing Project Performance	APP006	15	2
CC	APPEL - Crucial Conversations	CC01	14	2
CESA	APPEL - Concept Exploration and System Architecting	CESA30	36	4.5
CTI	APPEL - Communicating Technical Issues	CTI009	15	2
DA	APPEL - Decision Analysis	APPEL - DA	14	2
FSE	APPEL - Fundamentals of Systems Engineering	FSE031	35	5
IPM	APPEL - International Project Management	000005	44	4.5
LCP	APPEL - Leading Complex Projects	LCP015	21	3
NG	APPEL - Negotiations	NEG018	14	2
PAW	APPEL - Project Acquisition Workshop	APPEL - PAW	20	2.5
PBSOW	APPEL - Performance-Based Statement of Work	S20008	12	2
PM&SE	APPEL - Project Management and Systems Engineering	PMSEA02	63	8
PM-LAB	APPEL - Project Management Leadership Lab	PMLAB19	34	4.5
PPAC	APPEL - Project Planning Analysis and Control	FOU150	34	5
PSCHED	APPEL - Project Scheduling: Basics and Advanced Concepts	PSCHED01	14	2
REQ	APPEL - Requirements Development and Management	APPEL-REQ	20	3
RM I	APPEL - Risk Management I	RM022	7	1
RM II	APPEL - Risk Management II	APPEL - RM II	14	2
SAGE	APPEL - Seven Axioms of Good Engineering	SAGE33	20	3
SCC	APPEL - Scheduling and Cost Control	SCC023	28	4
SEMP	APPEL - Developing and Implementing a Systems Engineering Management Plan	SEMP11	22	3
STPS	APPEL - Strategic Thinking for Project Success	APPEL - STPS	23	3
TL	APPEL - Team Leadership	TL0024	17	2.5
UEVM	APPEL - Understanding Earned Value Management	APPEL-UEVM	7	1

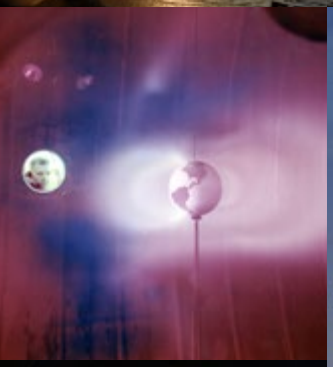
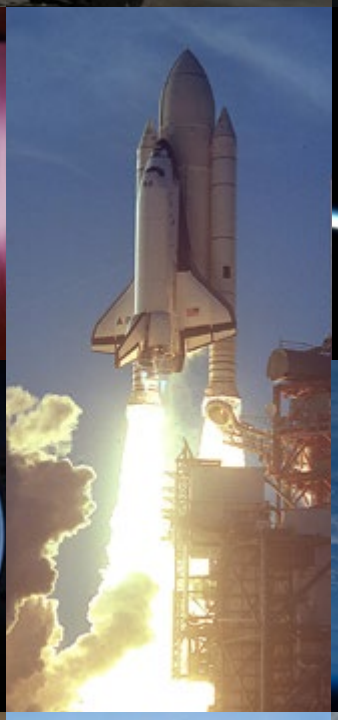
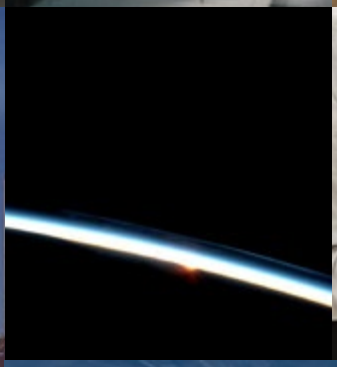
PHILOSOPHY

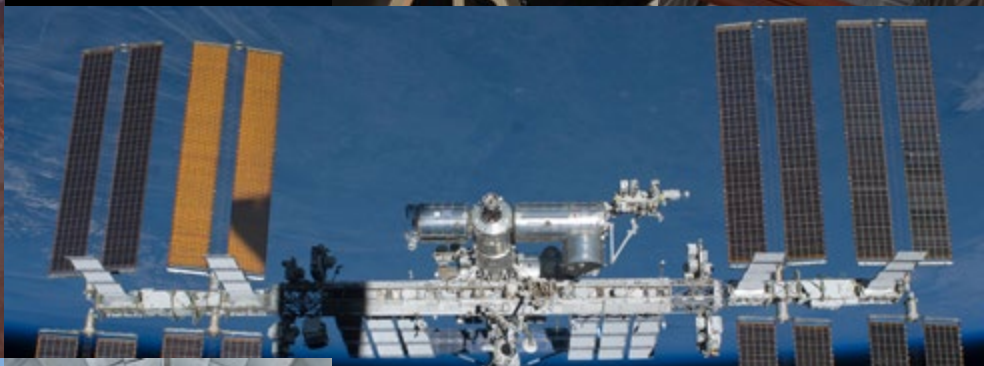
It is the intent of the Academy to ensure that NASA program/project managers, engineers, and systems engineers be supported in acquiring the knowledge and skills that will be required for their success at increasing levels of assignment complexity within the agency. The satisfactory completion of any or all the development activities should enhance an individual's capabilities, probability of success, and value as an asset to NASA. As individuals demonstrate improved quality in their job performance, the opportunities for assignment to increased levels of responsibility should be a possibility. An individual's competence will always be the critical factor in his or her consideration for advancement.

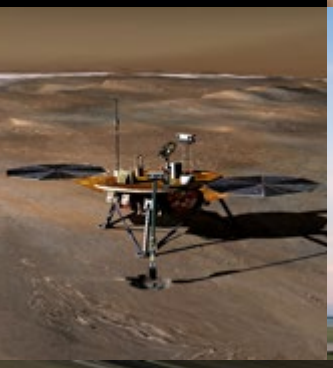

For more information visit
appel.nasa.gov







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